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JUN 30 189

THE ELECTRICAL REVIEW

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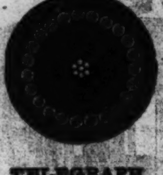

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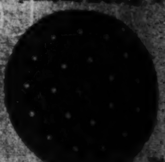

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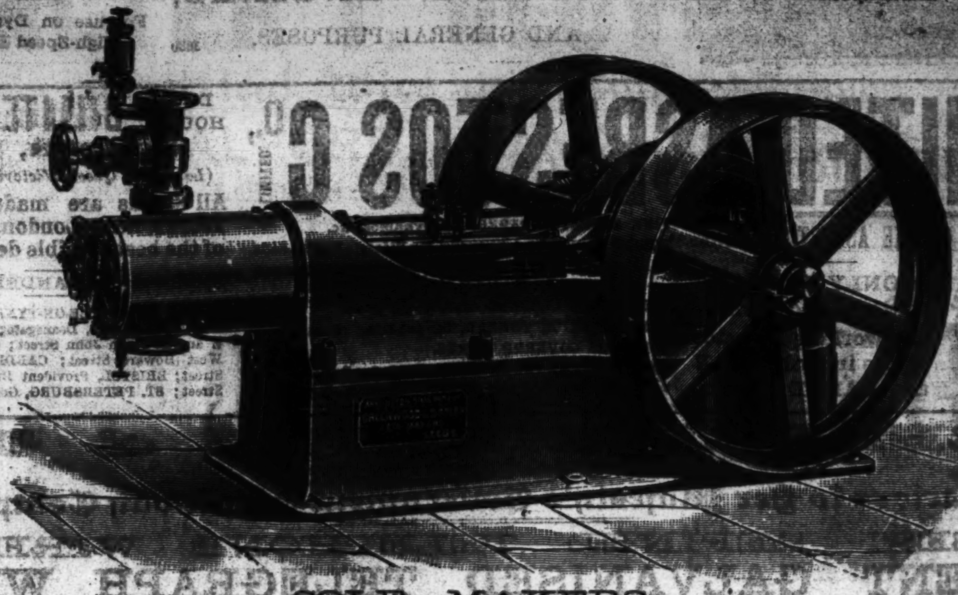

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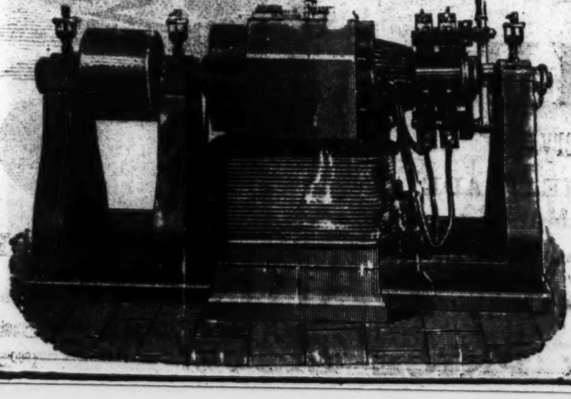

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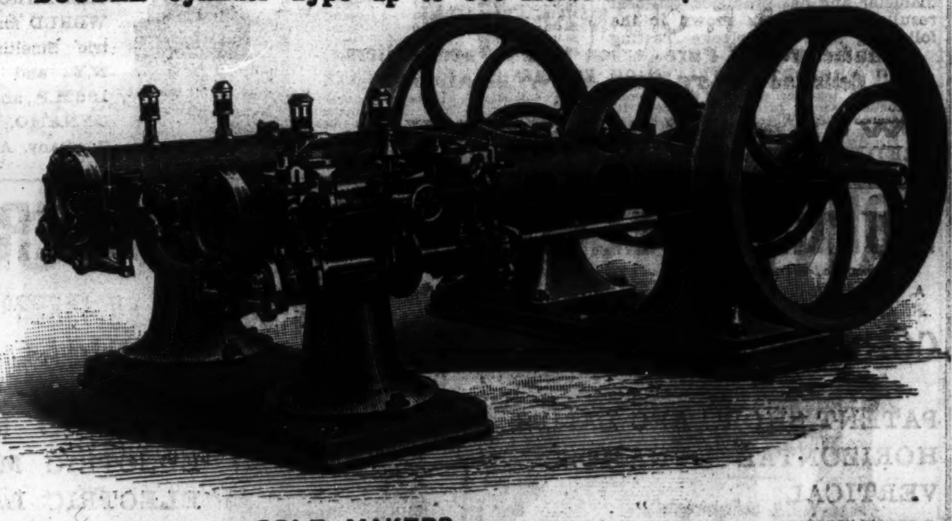

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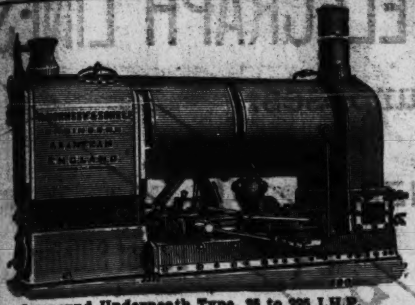

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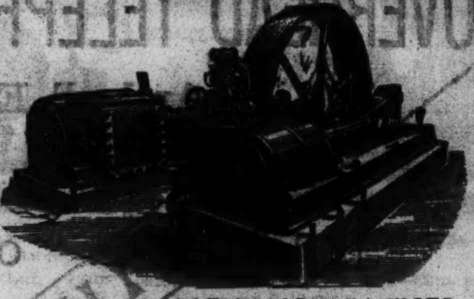

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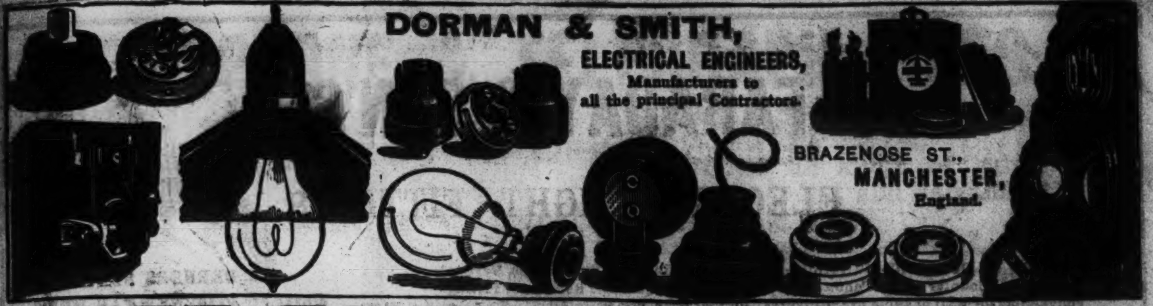
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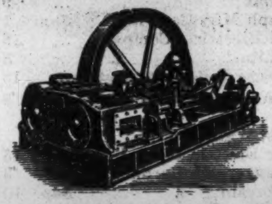

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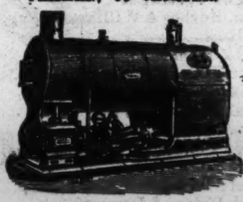

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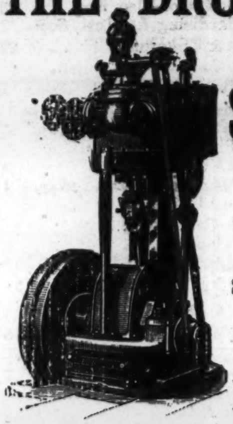

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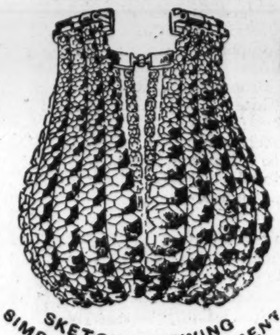

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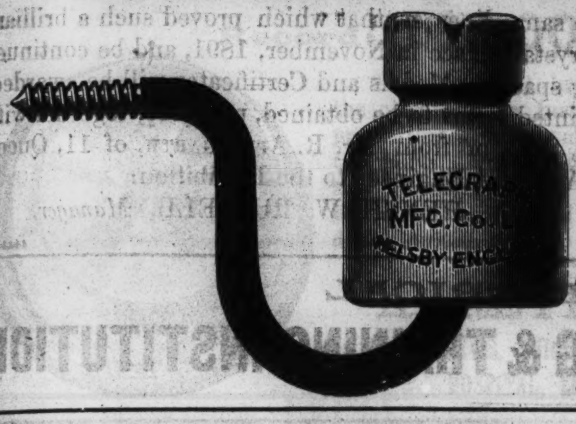

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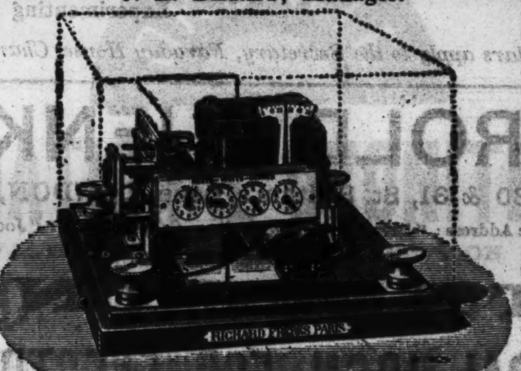

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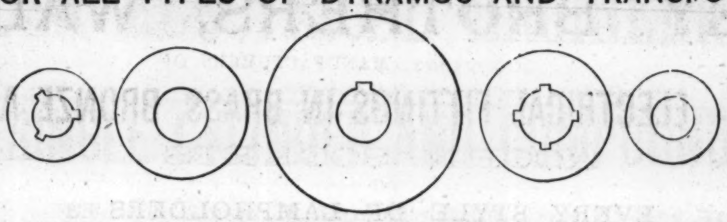

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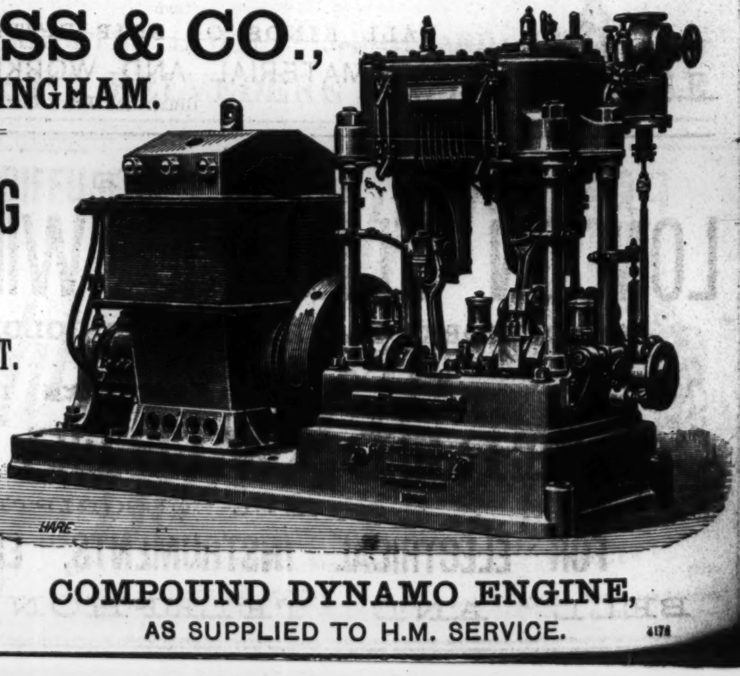

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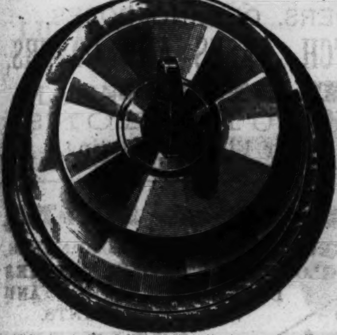

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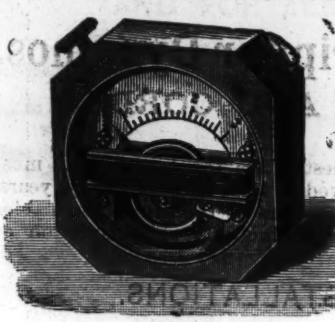

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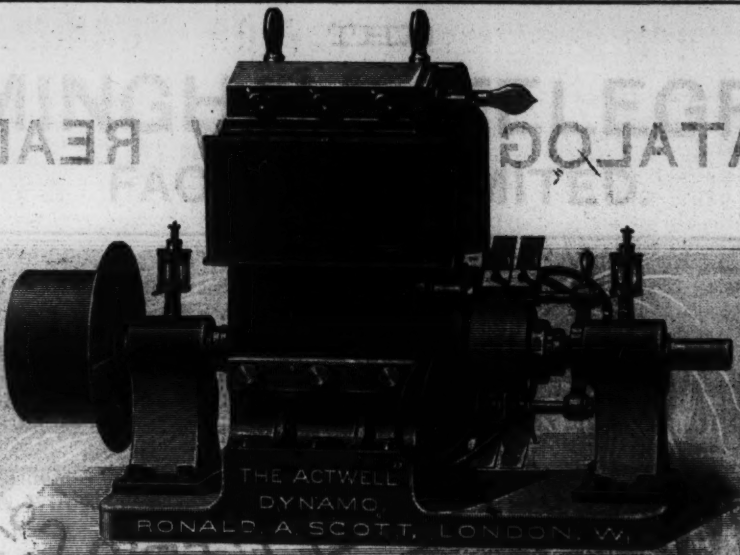

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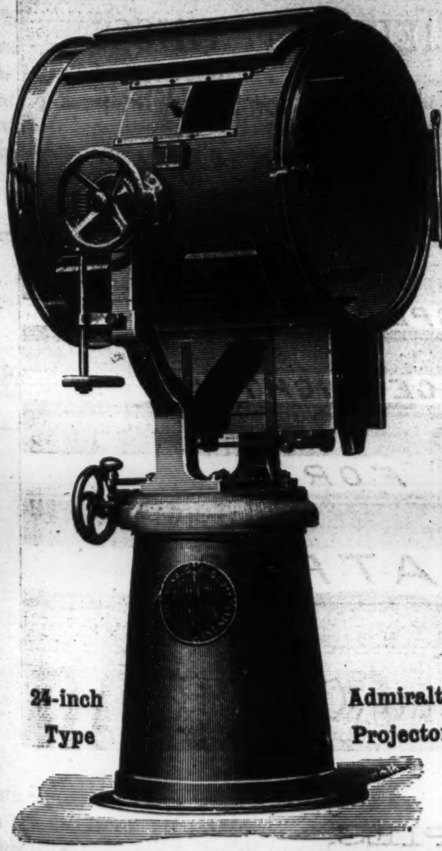

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Stand No. 15
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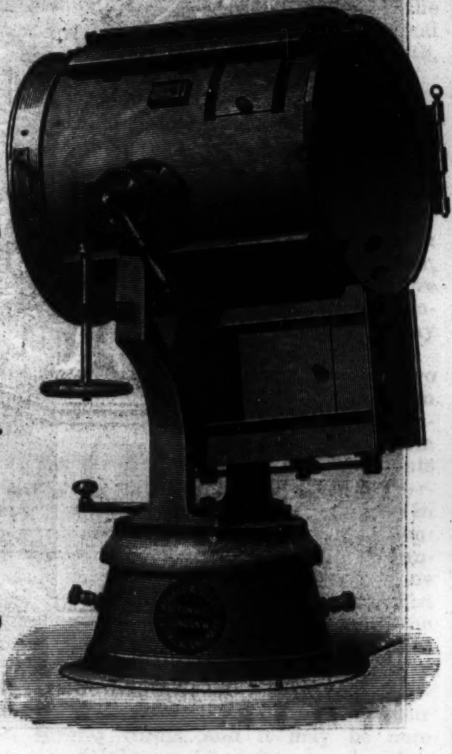
May, 1891.



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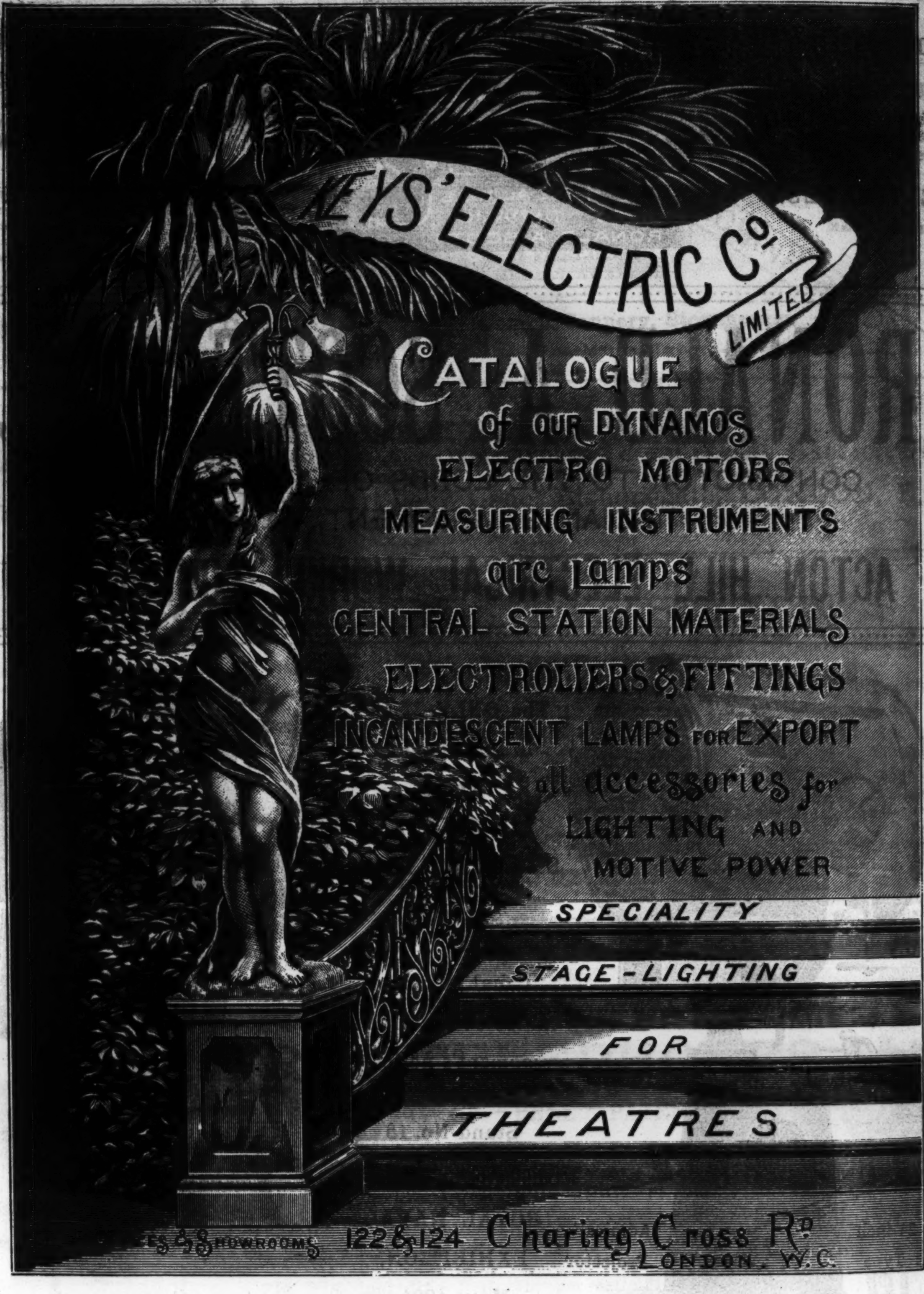

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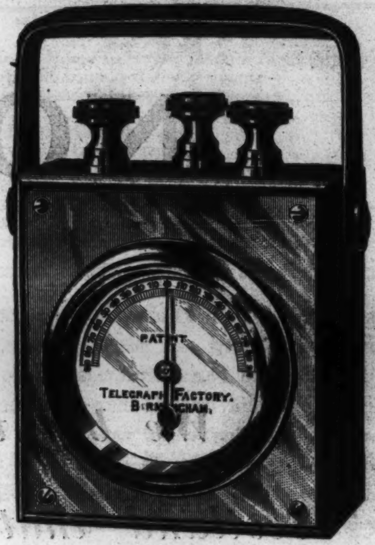
PATENT GALVANOMETER.

OUR illustration this week shows one of our specialities in the shape of an improved detector galvanometer. This galvanometer is much superior in appearance to the ordinary detector, being fitted in airtight case, the front of the instrument consisting of a brass plate carrying a heavy brass bezel in which the plate glass face is mounted—the axis of the needle being pivotted in the glass. As there is no bridge, a deflection, however sudden and violent, cannot strain the movement, as the needle will swing quite round. A neat leather handle, which falls back out of the way of the terminals, completes the instrument, which is wound with either thin or thick wire coils, or with both, as shown.



TELEPHONE TRANSMITTERS.

WE have received a large number of enquiries for particulars of our forthcoming patent transmitter, which we bring out on August 1st next, and we therefore think it desirable to make known a few of the important details in order that its leading points may be readily appreciated.

In the first place, our transmitter employs but two contacts, and does not contain carbon in the form of powder, granules, or balls, neither does its efficiency depend upon the use of an excessively thin diaphragm. Its position relative to certain patents which do not expire in July will thus be understood. Secondly, in the series of experiments in telephonic transmission which we have lately conducted, we have steadily kept in view a type of instrument capable of transmitting speech with one No. 2 Leclanché cell of the ordinary kind, and whilst we have endeavoured to attain as far as possible the utmost volume of transmitted sound, we have kept in mind the advisability of preserving the purity and tone of the voice. This we claim to have successfully provided for. Thirdly, we shall construct our transmitter in several forms, and it may be here remarked that the diaphragm may be placed either vertically or horizontally or in any intermediate position without detriment to its speaking properties. It will also be susceptible of the most delicate regulation to suit various circumstances. We are constructing it as a first-class electrical instrument, as we are confident that perfection of workmanship and finish are essential in the transmitter—the most delicate and important part of a telephone installation.

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"INDUCTION," MANCHESTER.
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THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXVIII. JUNE 19, 1891. No. 708

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THE INCANDESCENT LAMP IN THE STATES.

THE suit between the Edison Company and the United States Company, which was instituted some years ago, has not been prosecuted with much energy until quite recently. Time has been spent, and the trial put back, by a succession of motions by both sides. The stake at issue involves nothing less than the monopoly of the manufacture of incandescent lamps. The Edison Company claim that their patent, dated January the 27th, 1880, broadly covers the construction of the glow lamp as at present manufactured and used for ordinary household electric lighting. Should the Court put this reading upon the claims it will be a serious matter to other companies in the United States, and will greatly hamper and depreciate their trade, as well as entail upon them heavy pecuniary loss. The case is to be tried before Judge Wallace without a jury, but in spite of his high reputation in regard to his abilities and impartiality as a judge, a New York contemporary of ours regrets that the cause is not to be argued before a man who might be as eminent for his scientific as for his legal knowledge. In this regret we certainly coincide, and we have frequently expressed our opinion on the subject in the same strain. To whichever side the verdict may be favourable, it will doubtless be unsatisfactory to the other, so much so, that the present trial can only be looked upon as a preliminary affair. An appeal is possible to the Circuit Court of Appeals which is about to be organised under a recent statute; and from thence there remains the power to take the case into the Supreme Court of the United States.

It is impossible to predict how the case will go, for many points will come before the Courts which would have little or no effect on a similar matter tried in England; questions of sentiment will be introduced, and we may expect the name of Edison will carry with it sufficient weight to produce a large moral influence when the evidence has to be sifted. But it may be positively asserted that neither party will give in until every legal resource has been put into force and exhausted.

The litigation on the validity of the Edison patent prior to this suit consists of the two trials in England, the first being brought by the Edison and Swan United Company against Woodhouse and Rawson and the second against Holland and others, as our readers will recollect. In Germany the Swan Electric Light Company presented a petition to annul the Edison German patent on the plea that it was invalid in view of the state of the art at the time the patent was issued. This was won by the Edison Company, but was lost the next year on the appeal, the Court holding that the Swan lamp was not an infringement on Edison's patent. The claims in the German specification were not entirely similar to the English ones, and consequently the patents were not quite the same. Still another suit on the same subject has been tried in America. This is particularly interesting, as it involves some of the questions now at issue. The McKeesport Light Company was attacked by the Consolidated Electric Light Company for infringement of the Sawyer-Man patents. This was virtually a suit against the Edison Company for an infringement of the patents owned by the Westinghouse Company, just as the present one is a direct attack by the Edison Company upon the Westinghouse people. After a considerable amount of litigation a decision in the case was rendered by Justice Bradley, October 5th, 1889, which virtually upset the broad claim of the Sawyer-Man patents. The principal claim of Sawyer and Man was on an incandescing conductor made of carbonised fibrous textile material; the other claims of the patent relating to the arch-shaped form which is now almost universally used. Justice Bradley's decision, although it strongly sustains the Edison claims, specially in the particular of employing a very high resistance carbon, was very emphatic in its opinion regarding the state of the art.

The present suit turns on the interpretation of the following claims, which we give verbatim:—"1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance made as described and secured to metallic wires, as set forth." "2. A combination of carbon filaments, with a receiver made entirely of glass, and conductors passing through the glass, and from which receiver the air is exhausted, for the purposes set forth."

Reading the above by the light of the 10 years' experience since the date of the patent, the claims appear to cover every available method of manufacturing an incandescence lamp. But if we put on one side all that experience, and go back to the practical knowledge possessed by would-be manufacturers in 1879, it does not necessarily follow that the claims are as comprehensive as the wording would at first sight lead us to suppose.

It is stated in the specification that Mr. Edison had made filaments of cotton thread, wood splints, paper, and carbons of various forms. The drawings show a lamp, to all intents and purposes, outwardly similar to those now in use; but the description in the text sets forth a carbon composed of lampblack and coal tar drawn out to a filament and carbonised. This way of making a material for the bridge has never yet been successfully accomplished. With all the advantages of increased acquaintance with the manipulation and best means of producing filaments generally; with the use of every facility that a modern laboratory could afford, and with the expenditure of some considerable time, the exponents of the Edison patents, in the before-mentioned action against Holland and others, were unable to produce a single carbon manufactured according to the specification that was worth a cent. Small wonder, then, that Mr. Justice Kay, before whom the case was tried, taking into consideration also the prior work of earlier explorers in the same field, should have given a judgment adverse to the broad claim. Could the Court of Appeal, who upset this verdict, have heard all the evidence and noted the manner in which many witnesses gave it, it is more than probable that the judgment would have been allowed to stand.

In the McKeesport suit, Mr. Justice Bradley laid great stress on the state of the art at the time of application for the patents and the earlier work, and rejected all evidence that tended to view the subject from the standpoint of the present time.

The strongest point in the Edison claim is the use of the high resistance filament, which may perhaps be discounted by the fact that Edison published the advantages of the high resistance in his former patent for a platinum lamp. The Edison Company will rest their right to a monopoly on the basis that the first practical lamp in America was produced under their patent, and that high resistance is the most vital feature in a lamp to be commercially useful, but Bernstein's lamp is a direct contradiction to this latter claim.

For the defence, it is stated that there is reason to believe that an inventor in Boston, before the date of Edison's patent, made incandescent lamps in a similar manner, the incandescent bridge being composed of platinum wire or a carbon rod supported by platinum conductors. This lamp was not patented or published, so it is doubtful how it may be taken as an anticipation. Again, it is said, high resistance cannot fairly be claimed as an invention, because it was well understood in 1880 that transmitting devices in an electric circuit should be of sufficient resistance to ensure economy.

It will be of interest to watch the case closely, as not only being of great importance in itself, but also to see how far sentiment will carry weight, and how much reliance will be set on unpublished evidence.

TRACTION ON TRAMWAYS.

THE registration a few weeks ago of the London Electrical Tramways Company, Limited, with a capital of £150,000, in order to acquire the tramway system, equipment and undertaking of the North London Tramways Company, Limited, and to carry on numerous other businesses, once more brings prominently forward the employment of electric traction on British tramways. As far as practical work in this country is concerned, electricity as a motive power for tramways cannot be considered to have yet passed the experimental stage, since the few existing electric lines, either on the storage battery or direct system of supply, are very short, they were mainly put into operation for experimental purposes only, and they can therefore not be expected to yield the same results as would obtain in the case of a fully-equipped and practical electric tramway constructed to deal with the whole of the passenger traffic in any particular district.

The directors of English tramway companies have for reasons now tolerably well known, but which are, briefly, want of interest, absence of proof as to the commercial results of working a practical electric tramway, and lack of the capital necessary for the carrying out of such undertakings, up to the present held aloof from electric traction schemes, and they are now waiting for "something to turn up." They will, moreover, continue to wait until it can be demonstrated beyond suspicion that the working results of any particular system of electric traction prove that the undertaking has been commercially remunerative. Then they may awaken from the state of apathy, and possibly consider the question of raising the £ s. d. Of course, in a few isolated instances, companies may be found to make experiments, as in the cases of the North Metropolitan and the Birmingham Central Tramways Companies; but, beyond such steps, it is doubtful whether much, if any, important work will be done. It is, however, possible to remedy this state of affairs.

The formation of electrical companies for the supply of plant and the equipping of tramways *may* possibly yield good results at a distant period, but it is extremely improbable whether any one of the four leading traction companies has yet transacted any remunerative business; indeed, two of them have not done one iota—beyond spending money. Now, if a conclusion may be drawn from the existing condition of electric traction and the general feeling of tramway directors, it seems that electricity as a motive power for tramways can only be properly developed by the constitution of *bonâ fide* companies either for the construction of new lines or for the acquisition of any already in operation, and which could be converted into electric tramways. The former policy was adopted in the case of the City and South London Railway, whilst both steps are proposed to be taken by the London Electrical Tramways Company, Limited.

Though somewhat of a digression, a few words may be said about this undertaking, since the new company may sooner or later be brought before the investing public. With its capital of £150,000, the company intends to perform a large amount of work, as will be seen on reference to page 564 of our issue of the 1st ult. As already mentioned, one of its objects is the acquisition of the North London Tramways Company's system. According to *Duncan's Tramway*

Manual, this company went into liquidation in December, 1889, and the latest available report is that for 1888. The length of the lines is 12 miles, and 25 engines and 27 cars have been operated. The share capital is £73,020, the preference £73,980, and the debenture capital £33,090, or a total of £180,090. The traffic and other receipts in 1888 amounted to only £17,411, and the total expenses to £15,846. After paying debenture and other interest, there remained a balance of £262, no dividend being paid on either the preference or the ordinary shares. The number of passengers carried was 2,415,673, the receipts per mile run were 8·90d., and the expenses per mile run 8·23d. As the Board of Trade has recently refused to grant a renewal of the company's license to work steam cars, the service has been discontinued. This, then, is the position of the undertaking which the London Electrical Tramways Company, Limited, proposes to acquire, though how and upon what terms remain to be seen. At all events, the liquidation of the old company does not forebode well for the company which is to acquire the former's system, the managing director of which is one of the most prominent, well-informed and capable tramway men in this country. The heavy gradients on the line would, moreover, be a test which few electric tramways have to undergo.

It may reasonably be concluded that, provided the necessary capital can be raised, the formation of genuine electric traction companies on the lines already pointed out, and with the exclusion of the essentially "promoting element of bleeding," would do more to advance electric traction than anything else. If such undertakings are brought into existence, if they are properly managed, and if the working results show that street electric traction is superior to horse and steam haulage, the day will not be far distant when tramway directors will seriously think of transforming, by hook or by crook, their horse roads into electric tramways.

An Electric Flying Man.

The failure of the numerous inventors who have endeavoured to solve the problem of aerial navigation, or rather flying in the air, does not appear to deter others from trying to find the solution. M. Ader, of French telephone fame, is the latest addition. He is reported to have invented a flying machine in which electricity forms the motive power, and is said to have just made a successful ascent in the park of a Paris financier. He is said to have travelled at a height of 66 feet, a distance of from 300 to 400 yards, and to have ascended, descended and navigated himself according to his own sweet will. Of course all details of the apparatus, which is not a balloon, are rigorously kept secret and will not be made known until the inventor has made "an irrefutable demonstration in the presence of delegates of the Academie des Sciences." Most people will look forward with—well, doubts as to the "irrefutable demonstration" of the flying man.

Electric *versus* Horse Omnibuses.

In referring to the recent strike of the *employés* of the London General Omnibus and Road Car Companies, a contemporary suggests that the companies might find it advantageous to substitute electric omnibuses for those hauled by horses. Our contemporary says that "in some districts the cost of electric tramways is stated to be higher than that of those worked by horse-power." This implies that in other districts electric lines are more economical. With the exception of the short experimental tramway at Blackpool, it would be interesting if our contemporary could furnish data of the commercially successful lines operated in other districts; but probably its assertion is only a new invention. Again, the same journal opines that estimates regarding the respective cost of traction by electric and horse omnibuses would form an effective comparison as to the merits of each system, and recommends that such figures should be compiled by electrical and mechanical institutes. Estimates of the kind mentioned are utterly valueless; what is required are *facts*, and these will only be forthcoming *after* electric omnibuses come into use. Moreover, it is extremely doubtful whether the company owning the "only one" existing electric 'bus in this country would care for the publication of the working results during the past four years. Possibly, when money gets a little easier, and when the investing public has more confidence in electrical schemes, something definite may be heard of the line of six omnibuses.

An Unknown Patent.

The article which we publish from the pen of Mr. A. M. Tanner, was prompted by the oft repeated claim that Gramme discovered the transmission of power by electricity, and the fact that a company in the United States makes claim to the broad idea of an electric railway with an overhead conductor and a travelling connection. Now it is apparent that the Bessolo patent is not known (or if known only slightly) to the English and American electrical profession or public, and hence we deem the matter of sufficient importance to publish the article, notwithstanding the fact that Mr. Tanner was forestalled somewhat by *La Lumière Electrique* of 1883. As this article, however, does not consider the special bearing of the patent upon transmission of power, and has not an entire description concerning railway propulsion, we agree with the author that the time is opportune for publication of the article, even if the matter is treated as a reprint.

The Stockwell Electric Railway.

A curious illustration has been afforded by the new Electric Railway to Stockwell of the sensibility of modern scientific instruments. An automatic record is kept at the Royal Observatory of earth currents and magnetic disturbances. These are usually of an atmospheric origin, or the results of variations in terrestrial magnetism; but, strange to say, since the opening of the underground electric line the registering needles at Greenwich have been regularly thrown into vibration exactly at the periods when the trains are running. As these are different on Sundays and weekdays, there seems little doubt that this is the true cause of the disturbance. Mr. William Ellis, of the Observatory, communicates a report on the subject to *Nature*, and remarks that the correspondence of cause and effect is complete. The railway tunnel is over two miles from the nearest earthplate connected with the Observatory; but the currents set up are sufficiently strong to make very distinct deflections. The whole matter is better seen in the annexed tabular statement:—

Times of interference with earth-current registers at the Royal Observatory, Greenwich.	Train service on Electric Railway.
On week days.	On week days.
From shortly before 7 a.m. until shortly after 11 p.m.	First train from Stockwell 6.40 a.m. " " City ... 6.50 a.m. Last train from Stockwell 10.46 p.m. " " City ... 10.58 p.m.
On Sundays, commencing April 5th.	On Sundays, commencing April 5th.
From about 1 p.m. untill 10 p.m. or shortly afterwards.	First train from Stockwell 1.0 p.m. " " City ... 1.5 p.m. Last train from Stockwell 9.30 p.m. " " City ... 9.30 p.m.

It would be interesting to know what effect, if any, the Deptford system has had upon the instruments in the Royal Observatory. Disturbances have previously been attributed both to this and to the Albert Docks installation, but they have been difficult to trace to either; perhaps Mr. Ellis has now more definite statistics at hand?

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THE registration a few weeks ago of the London Electrical Tramways Company, Limited, with a capital of £150,000, in order to acquire the tramway system, equipment and undertaking of the North London Tramways Company, Limited, and to carry on numerous other businesses, once more brings prominently forward the employment of electric traction on British tramways. As far as practical work in this country is concerned, electricity as a motive power for tramways cannot be considered to have yet passed the experimental stage, since the few existing electric lines, either on the storage battery or direct system of supply, are very short, they were mainly put into operation for experimental purposes only, and they can therefore not be expected to yield the same results as would obtain in the case of a fully-equipped and practical electric tramway constructed to deal with the whole of the passenger traffic in any particular district.

The directors of English tramway companies have for reasons now tolerably well known, but which are, briefly, want of interest, absence of proof as to the commercial results of working a practical electric tramway, and lack of the capital necessary for the carrying out of such undertakings, up to the present held aloof from electric traction schemes, and they are now waiting for "something to turn up." They will, moreover, continue to wait until it can be demonstrated beyond suspicion that the working results of any particular system of electric traction prove that the undertaking has been commercially remunerative. Then they may awaken from the state of apathy, and possibly consider the question of raising the £ s. d. Of course, in a few isolated instances, companies may be found to make experiments, as in the cases of the North Metropolitan and the Birmingham Central Tramways Companies; but, beyond such steps, it is doubtful whether much, if any, important work will be done. It is, however, possible to remedy this state of affairs.

The formation of electrical companies for the supply of plant and the equipping of tramways *may* possibly yield good results at a distant period, but it is extremely improbable whether any one of the four leading traction companies has yet transacted any remunerative business; indeed, two of them have not done one iota—beyond spending money. Now, if a conclusion may be drawn from the existing condition of electric traction and the general feeling of tramway directors, it seems that electricity as a motive power for tramways can only be properly developed by the constitution of *bonâ fide* companies either for the construction of new lines or for the acquisition of any already in operation, and which could be converted into electric tramways. The former policy was adopted in the case of the City and South London Railway, whilst both steps are proposed to be taken by the London Electrical Tramways Company, Limited.

Though somewhat of a digression, a few words may be said about this undertaking, since the new company may sooner or later be brought before the investing public. With its capital of £150,000, the company intends to perform a large amount of work, as will be seen on reference to page 564 of our issue of the 1st ult. As already mentioned, one of its objects is the acquisition of the North London Tramways Company's system. According to *Duncan's Tramway*

Manual, this company went into liquidation in December, 1889, and the latest available report is that for 1888. The length of the lines is 12 miles, and 25 engines and 27 cars have been operated. The share capital is £73,020, the preference £73,980, and the debenture capital £33,090, or a total of £180,090. The traffic and other receipts in 1888 amounted to only £17,411, and the total expenses to £15,846. After paying debenture and other interest, there remained a balance of £262, no dividend being paid on either the preference or the ordinary shares. The number of passengers carried was 2,415,673, the receipts per mile run were 8·90d., and the expenses per mile run 8·23d. As the Board of Trade has recently refused to grant a renewal of the company's license to work steam cars, the service has been discontinued. This, then, is the position of the undertaking which the London Electrical Tramways Company, Limited, proposes to acquire, though how and upon what terms remain to be seen. At all events, the liquidation of the old company does not forebode well for the company which is to acquire the former's system, the managing director of which is one of the most prominent, well-informed and capable tramway men in this country. The heavy gradients on the line would, moreover, be a test which few electric tramways have to undergo.

It may reasonably be concluded that, provided the necessary capital can be raised, the formation of genuine electric traction companies on the lines already pointed out, and with the exclusion of the essentially "promoting element of bleeding," would do more to advance electric traction than anything else. If such undertakings are brought into existence, if they are properly managed, and if the working results show that street electric traction is superior to horse and steam haulage, the day will not be far distant when tramway directors will seriously think of transforming, by hook or by crook, their horse roads into electric tramways.

An Electric Flying Man.

The failure of the numerous inventors who have endeavoured to solve the problem of aerial navigation, or rather flying in the air, does not appear to deter others from trying to find the solution. M. Ader, of French telephone fame, is the latest addition. He is reported to have invented a flying machine in which electricity forms the motive power, and is said to have just made a successful ascent in the park of a Paris financier. He is said to have travelled at a height of 66 feet, a distance of from 300 to 400 yards, and to have ascended, descended and navigated himself according to his own sweet will. Of course all details of the apparatus, which is not a balloon, are rigorously kept secret and will not be made known until the inventor has made "an irrefutable demonstration in the presence of delegates of the Academie des Sciences." Most people will look forward with—well, doubts as to the "irrefutable demonstration" of the flying man.

Electric *versus* Horse Omnibuses.

In referring to the recent strike of the *employés* of the London General Omnibus and Road Car Companies, a contemporary suggests that the companies might find it advantageous to substitute electric omnibuses for those hauled by horses. Our contemporary says that "in some districts the cost of electric tramways is stated to be higher than that of those worked by horse-power." This implies that in other districts electric lines are more economical. With the exception of the short experimental tramway at Blackpool, it would be interesting if our contemporary could furnish data of the commercially successful lines operated in other districts; but probably its assertion is only a new invention. Again, the same journal opines that estimates regarding the respective cost of traction by electric and horse omnibuses would form an effective comparison as to the merits of each system, and recommends that such figures should be compiled by electrical and mechanical institutes. Estimates of the kind mentioned are utterly valueless; what is required are *facts*, and these will only be forthcoming *after* electric omnibuses come into use. Moreover, it is extremely doubtful whether the company owning the "only one" existing electric 'bus in this country would care for the publication of the working results during the past four years. Possibly, when money gets a little easier, and when the investing public has more confidence in electrical schemes, something definite may be heard of the line of six omnibuses.

An Unknown Patent.

The article which we publish from the pen of Mr. A. M. Tanner, was prompted by the oft repeated claim that Gramme discovered the transmission of power by electricity, and the fact that a company in the United States makes claim to the broad idea of an electric railway with an overhead conductor and a travelling connection. Now it is apparent that the Bessolo patent is not known (or if known only slightly) to the English and American electrical profession or public, and hence we deem the matter of sufficient importance to publish the article, notwithstanding the fact that Mr. Tanner was forestalled somewhat by *La Lumière Electrique* of 1883. As this article, however, does not consider the special bearing of the patent upon transmission of power, and has not an entire description concerning railway propulsion, we agree with the author that the time is opportune for publication of the article, even if the matter is treated as a reprint.

The Stockwell Electric Railway.

A curious illustration has been afforded by the new Electric Railway to Stockwell of the sensibility of modern scientific instruments. An automatic record is kept at the Royal Observatory of earth currents and magnetic disturbances. These are usually of an atmospheric origin, or the results of variations in terrestrial magnetism; but, strange to say, since the opening of the underground electric line the registering needles at Greenwich have been regularly thrown into vibration exactly at the periods when the trains are running. As these are different on Sundays and weekdays, there seems little doubt that this is the true cause of the disturbance. Mr. William Ellis, of the Observatory, communicates a report on the subject to *Nature*, and remarks that the correspondence of cause and effect is complete. The railway tunnel is over two miles from the nearest earthplate connected with the Observatory; but the currents set up are sufficiently strong to make very distinct deflections. The whole matter is better seen in the annexed tabular statement:—

Times of interference with earth-current registers at the Royal Observatory, Greenwich.	Train service on Electric Railway.
On week days.	On week days.
From shortly before 7 a.m. until shortly after 11 p.m.	First train from Stockwell 6.40 a.m. „ „ City ... 6.50 a.m. Last train from Stockwell 10.46 p.m. „ „ City ... 10.58 p.m.
On Sundays, commencing April 5th.	On Sundays, commencing April 5th.
From about 1 p.m. untill 10 p.m. or shortly afterwards.	First train from Stockwell 1.0 p.m. „ „ City ... 1.5 p.m. Last train from Stockwell 9.30 p.m. „ „ City ... 9.30 p.m.

It would be interesting to know what effect, if any, the Deptford system has had upon the instruments in the Royal Observatory. Disturbances have previously been attributed both to this and to the Albert Docks installation, but they have been difficult to trace to either; perhaps Mr. Ellis has now more definite statistics at hand?

NEW MODELS OF THE OXIDE OF COPPER BATTERY.

By M. F. DE LALANDE.

THESE new types are characterised by the employment of oxide of copper in the form of agglomerate slabs having a metallised surface. They constitute an improvement on the battery invented some years ago by Messrs. de Lalande and Chaperon, the well-known reaction of this battery being utilised in the new types, viz., the dissolution of zinc in caustic potash and the depolarisation by the oxide of copper, which absorbs hydrogen when passing into the metallic state.

In the models of 1884, the oxide of copper was generally employed in the form of grains scattered over the bottom of a metallic vessel forming the recipient of the element (trough battery element) or else placed in a cup in the bottom of a glass vessel (spiral element). The zinc was placed in the upper part of the vessel, in the form of a horizontal plate or a spiral band.

One of the most interesting peculiarities of the zinc-oxide of copper couple is the increase of depolarising power in proportion to the work of the element. This rare phenomenon of a battery whose available energy goes on increasing from the commencement of the discharge, before arriving at a state of regular action, is easily explained. The oxide of copper being a bad conductor of electricity can only depolarise at the points of contact with the electrode, but the copper produced by its reduction conducting very well the extent of surface affected by the depolarisation increases very rapidly, and the absorption of the hydrogen is facilitated and becomes more rapid; thus a kind of formation takes place in the electrode. If, therefore, the cakes manufactured as described, were employed in their original condition in batteries, then as the depolarisation would be imperfect at first, the parts in contact with the metallic support alone being able to act through their small extent of surface, the element should be closed upon itself for some minutes in order to get into good condition.

The slabs of oxide transformed into metallic copper by the work of the battery can be employed over and over again, after being washed, roasted and metallised.

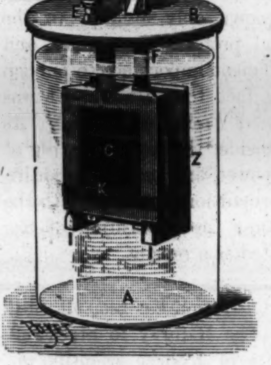

FIG. 1.

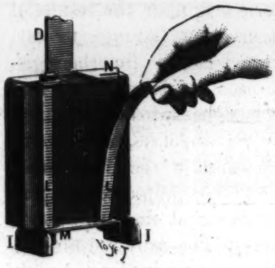

FIG. 4.

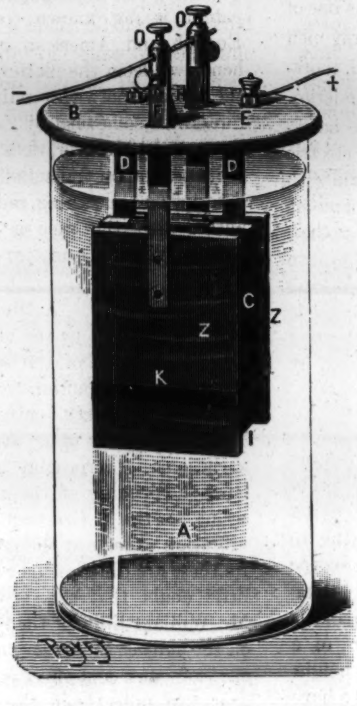

FIG. 2.

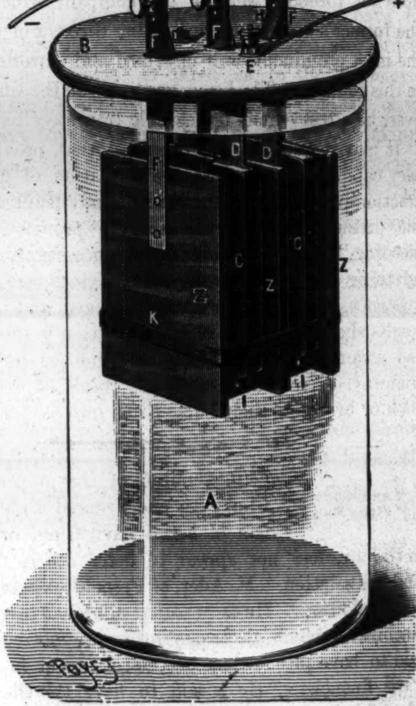

FIG. 3.

In the new models (figs. 1, 2 and 3) the slabs of agglomerated oxide of copper, C, are kept vertically opposite the plates of zinc, Z, Z, against the metal supports, D, D, fixed to the lids, B, B, of the elements. The whole is plunged into a solution of potash of about 35 per cent. contained in a glass vessel A. This method possesses, amongst other advantages, that of giving elements which are more compact and more easily displaced. The cakes of oxide of copper can be prepared by moulding by hydraulic pressure a moist mass of copper scales mixed with 4 to 5 per cent. of clay and baking the compound in a temperature of from 600 to 700 degrees Centigrade. The copper scales can also be mixed with from 6 to 8 per cent. of pitch, moulded and heated to red heat in a reverberatory furnace.

First a reduction of the oxide takes place which results in the agglomeration of the mass; then, under the influence of the air, the metal becomes oxidised without undergoing any change of form. The plates thus manufactured, although they do not contain any foreign matter, possess great solidity. Their porosity, in either case, is sufficient for the total mass of the oxide to exercise its depolarising action without introducing any appreciable resistance into the battery.

These new elements have been manufactured in three different dimensions. In the small model (fig. 1) the agglomerate slab is in the form of a square, the side of which measures 8 centimetres and weighs 150 grammes, this simplified model contains one single plate of zinc. The medium model (fig. 2) is provided with a slab, 11 centimetres square and weighing 450 grammes, and two zincs; the large model (fig. 3) contains two similar slabs and three zincs.

The system of mounting the slabs of oxide and the zincs is the same for the three models. The support of the agglomeration, D, D′ (fig. 2), is fixed to the porcelain lid, B, by means of screws, one of the screws bearing the positive terminal, E. It consists of a sheet of coppered sheet iron, rectangular in form, and hollowed out, with portions folded back so as to form a resting place for the plate. To mount the agglomeration it is placed in the position which it is intended to occupy (fig. 4) and held there by means of two spring keys of hammered copper, in the form of a curve, the lower extremities of which pass into the eyes, M, M, pierced in the base of the support; the upper parts of the springs are then forced into the slots, N, N. The very rapid mode of mounting keeps the agglomerations in good metallic contact with the support.

As to the zincs, they are supported by metallic plates, F, F, passing into rectangular holes pierced in the lid. To the upper part of these plates are fixed steel springs, H, H, which are capable of bending and so passing through the lid, and then resuming their former position; they support the weight of the zinc by bearing on the surface of the lid. In the small model, a conducting wire is fixed to the zinc, in the other models, metal clamps, O, O, O, are placed on each of the zincs and connected by the negative conductor. Moreover, the zincs are kept at the required distance from the positive electrode by ebonite insulators, I, I, fixed on the supports of the oxide of copper. The *ensemble* of agglomerate slabs and zincs is encircled by an India-rubber band, K.

The zincs should be kept completely submerged on account of their liability to split if exposed above the surface of the liquid. Their supports are generally made of amalgamated copper or brass. Tinned iron can also be employed, being both more resistant and cheaper. In fact the tin is not attacked and does not give rise with the zinc to a disengagement of hydrogen. The electrodes are not submerged as far as the bottom of the vessels; the zincate of potash which is formed during the working of the battery, separates pretty readily, on account of its great density, settling in a layer at the bottom of the vessel. The electrodes being brought near the surface, thus remain as long as possible in the solution of potash which is to attack them.

The general properties of the oxide of copper battery are well known. It is up to the present the only primary element mounted permanently which is capable of a large output and which only consumes its products in proportion to the work furnished.

The employment of slabs with a metallised surface causes a very large depolarising surface to act from the commencement, thereby increasing the constancy of the elements. The proximity of the surfaces diminishes the internal resistance. The outputs are consequently greater, and the constancy more complete for elements of corresponding dimensions in the new models than in the old ones.

The curves shown in figs. 5 and 6 represent the discharges of the small (I.) medium (II.) and large (III.) models respectively, over resistances of $\frac{1}{2}$, $\frac{2}{10}$ths and $\frac{1}{10}$th of an ohm. The intensities are at first 1·18, 3·25 and 6·4 ampères. We can gather from these curves that the intensity does not, on an average, lose more than from 2 to 3 thousandths of its value per hour, when the battery is in action continuously for three whole days. If the discharge took place at successive intervals and not continuously, the constancy would evidently be still greater. If we attribute the variation in intensity during the discharge solely to the increase in the internal resistance, admitting that the electromotive force of the elements closed upon the resistances indicated falls to ·8 of a volt, and remains at that value, we find that the internal resistances of the elements vary :—

For the small model from ·179 to ·39 of an ohm
„ medium „ „ ·046 „ ·096 „
„ large „ „ ·025 „ ·051 „

The final resistance rarely amounting to more than double its initial value. Practically, the resistances certainly fall below the above figures, but a slight polarisation takes place.

When the work is intermittent we can obtain from the various elements with sufficient constancy, outputs of 4, 12 and 25 ampères.

The quantity of electricity available at any given moment, even several months after mounting, is according to the models 75, 300 and 600 ampère hours. Reckoning ·6 of an effective volt per element, we should obtain respectively, before the solution of potash and the cakes of oxide of copper are practically exhausted 45, 180 and 360 watt hours.

These new models of the oxide of copper battery seem capable of rendering important service in the various applications in which it is essential that the current should be powerful, constant, and always ready to act.

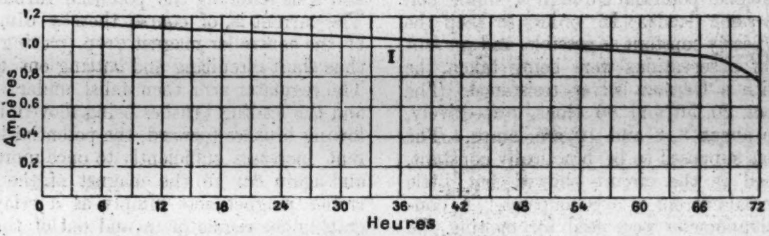

FIG. 5.

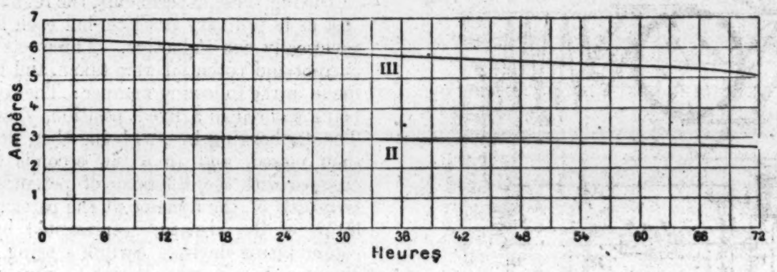

FIG. 6.

A STUDY OF AN OPEN COIL ARC DYNAMO.*

BY MILTON E. THOMPSON.

OF all the dynamo machines in use at the present day, perhaps the internal action of none is so little understood as that of the arc lighting machines of the open-coil armature class. Much concerning the regulation and general behaviour of these machines seems utterly at variance with what one would naturally expect from a superficial examination of the design and construction, and it was with the idea of throwing some light on this seeming mystery that the investigation to be described was undertaken. In carrying out this work no attempt has been made to determine the efficiency of the dynamo, or to determine an answer to the question, Is the machine well suited for arc lighting? The vast numbers of these dynamos in daily use in all parts of the world is a practical answer which must carry more weight than any which might be suggested by a theoretical study of the machine. The experimental work of this investigation was carried out under the direction of Prof. Nichols in the laboratories of Cornell University, during the past winter, by the writer, with the assistance of Mr. H. J. Hotchkiss and Mr. E. L. Morley, and due credit must be given to these gentlemen for any points of interest which may have been brought out by the investigation.

The object in view was to determine accurately, by taking instantaneous values throughout the revolution, the character of the external and internal currents and electromotive forces.

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* A paper read before the American Institute of Electrical Engineers, May 21st, 1891.

The capacity of the dynamo in question was about 10 arc lamps of 1,200 C.P.

In order to carry out this work it was necessary to build a special commutating device of a character somewhat similar to a number of others before used in the Cornell laboratories for taking instantaneous values of current and potential. Prof. Ryan was the first to introduce this method at Cornell, which is a modification of that described by Joubert in 1881,[*] and the device he used was described at length in a paper read before the Institute[†] on December 17th, 1889. The device consisted essentially of a metal tongue mounted upon the shaft of the dynamo and revolving with it, and making contact once each revolution with a small metal spring mounted upon an arm which was so arranged that it could be revolved about an axis coincident with that of the armature of the dynamo and secured in any desired position. By properly adjusting the position of the arm carrying this spring, contact could be made to take place between the spring and the tongue at any desired point of the entire revolution of the armature.

Three sets of curves of exterior current and potential were taken with three different loads upon the machine, and three sets of curves of current and potential through a single coil were taken with the same loads. In order to keep the electromotive force as nearly constant as possible, and prevent variations while a set of observations were being taken, the machine was loaded with a German silver resistance. The loads consisted of about 20, 50 and 80 ohms, respectively, and were equivalent to about 3, 6 and 10 arc lamps. The current for all loads was supposed to be practically constant, and an ammeter placed in the circuit showed but little variation from the normal current of 6·8 ampères. A condenser and ballistic galvanometer were used for making the measurements, and fig. 1 shows a diagram of the connection of the dynamo and also of the measuring apparatus. Referring to the diagram, A is the armature, F, F, the field coils, M the regulator magnet, Ċ the controller magnet, and *r* the carbon resistance used to prevent excessive sparking at the contacts K; P is the positive terminal of the machine, and N the negative, R is the German silver resistance which constituted the load for the dynamo, and *i* is a resistance of about one ohm placed in the circuit to serve as a basis for the current measurements. L, L, and S, S, are the brushes of the dynamo, which bear against the three segments of the commutator, as shown in the diagram; D is a condenser, K a discharging key, and J a small spring switch; G is a ballistic galvanometer, through which the condenser was discharged, and T is a shunt box for regulating the throw of the galvanometer and bringing it within proper limits. From the negative terminal of the machine, N, runs a wire to the commutating device, *c*, *s*, and from that to the switch, J. From the positive terminal, P, and the binding post, B, run wires to *f* and *g* of the switch *f*, *g*, *h*, as shown. From *g* of this switch runs a wire to the discharging key, K.

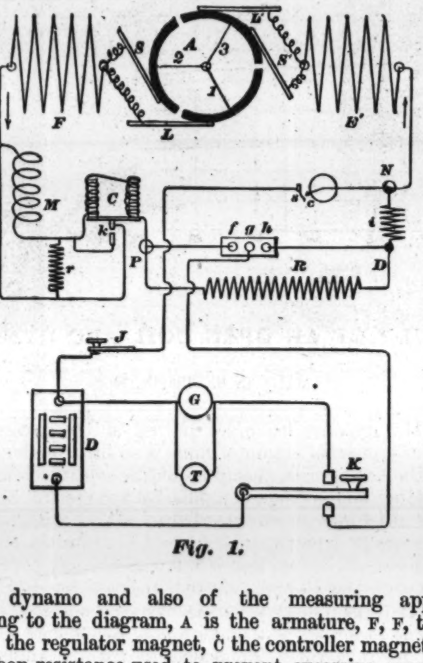

Fig. 1.

Before describing the methods of taking the measurements, it may be well to review briefly the operation of the dynamo and its regulation so far as is apparent from an outside view. The current, leaving the armature through the brushes, L and S, passes through the left field coil, and thence through the regulator magnet and controller magnets to the positive terminal, P, of the machine. Passing around through the external circuit, in this case the resistance, R, the current returns to the machine by the negative terminal, N, passes through the right field coil, F, and through the brushes, L and S, to the armature, thus completing the circuit. The regulation of the machine is effected as follows:—The controller magnet, C, is so adjusted, by means of a spring, that a current of 6·8 ampères will just raise the cords of the magnets and separate the contacts, *k*. This permits the current to flow through the regulator magnet, M, and raises the regulator arm, thereby shifting the leading brushes, L and L′, forward, and the following brushes, S and S′, backward, and thus reducing the potential furnished by the machine. The current is, of course, thereby diminished, and the cores of the controller magnet drop, closing the contacts, *k*, and thus short-circuiting and cutting out the regulator magnet. The regulator arm then falls, under the action of gravity, and the leading brushes being moved backward, and the following brushes forward, the potential is raised until the current increases sufficiently to once more open the contacts, *k*, and again cut in the magnet of the regulator. The controller magnet acts simply as a relay, and is continually cutting the regulator in and out of the circuit, and in this way the current is maintained constant, regardless of the varying conditions of the external circuit.

During these experiments, the regulator was allowed to act just as in ordinary practice, but each load was constant, and practically non-inductive. Three sets of curves of external current and potential were taken, and the measurements were made in the following manner: The commutating device, *c*, *s*, being secured in a fixed position, *f* and *g* were connected. The discharging key, K, being then depressed, switch, J, was then closed, and in a few seconds the condenser became charged with the difference of potential existing between the terminals of the dynamo at the particular point of the revolution of the armature represented by the position of the commutating device. Switch J being then opened, the discharging key, K, was allowed to rise, and the condenser was thus discharged through the galvanometer, G, causing a deflection, which was duly noted. The connections of the switch, *f*, *g*, *h*, were then changed, so that *g* and *h* were joined, and in this way the condenser was charged with the difference of potential existing between the points B and N of the external circuit at the same point of the revolution as the first reading. The condenser was then discharged through the galvanometer, and the deflection noted as before.

After moving the contact spring, *s*, forward 10 degrees, the measurements just described were repeated, and so on until the contact had been moved entirely around the circle.

The condenser and galvanometer being properly calibrated, it was an easy matter to calculate from the data obtained as above, the difference of potential between the terminals, P and N, and between B and N, at 36 points of the revolution of the armature. The resistance between B and N being known, the current was readily determined from the fall of potential. The results of these measurements are given in Table I., and are shown graphically in fig. 3, and will be referred to later.

After taking curves of the exterior potential and current, the apparatus was arranged for measuring the potential and current in a single coil of the armature. Coil No. 2 was selected as likely to present results nearest the average of all three of the coils, and the apparatus was arranged as shown in fig. 2. The circuit of the dynamo and its loads were exactly as for the first measurements, and the connections of the measuring instruments were as shown in the diagram. Referring to fig. 2, *a* is a small brush which bears against a ring, *d*, secured to the commutator, but carefully insulated from it. This ring is connected to the commutator bar of coil No. 2, and thus gives metallic connection with this bar at all points of the revolution. A small brush, *b*, bears against a similar ring wound round the armature shaft, but insulated from it. This last ring is connected to the three inner ends of the three coils, and thus a continuous contact is made with these ends. The outer end of coil No. 2 was disconnected from the commutator bar, and a small non-inductive resistance, *e*, was inserted between the end of the coil and the bar. The junction of the coil and the resistance, *e*, was connected to the tongue, *c*, which revolved with the armature shaft. Once during each revolution the tongue, *c*, made contact with the small spring, *s*, from which a wire ran to the switch, J, and thence to one terminal of the condenser, D. Wires ran from brushes, *a* and *b*, to the switch, *f*, *g*, *h*, and from this switch a wire ran to the discharging key, K, as shown on the diagram. When *g* and *h* were connected, and keys J and K depressed, the condenser was charged with the difference of potential existing between the ends of coil 2 as the particular point of the revolution represented by the position of the contact spring, *s*. The condenser being then discharged through the galvanometer, a measure of this difference of potential was thus obtained. Switch *f*, *g*, *h* was then changed so that *g* and *h* were connected, and measurements then taken with the condenser and galvanometer gave the difference of potential between the ends of the non-inductive resistance, *e*, and from this the current in coil 2 was calculated. Readings were taken in this way at distances of five degrees apart all around the revolution, and the results are given in Table II., and are shown plotted out in figs. 4, 5 and 6, three curves at three different loads being taken, as before. It is not the purpose of the writer to go into the theories of cause and effect as exemplified in these curves, but to simply present them, calling attention briefly to some few of the more noticeable and interesting features connected with them.

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[*] Joubert; Etudes sur les Machines Magneto-Electriques; *Annales de l'École Normale-Superieur*, 10, 46 pp., 1881.

[†] *Transactions*, vol. vii., p. 3.

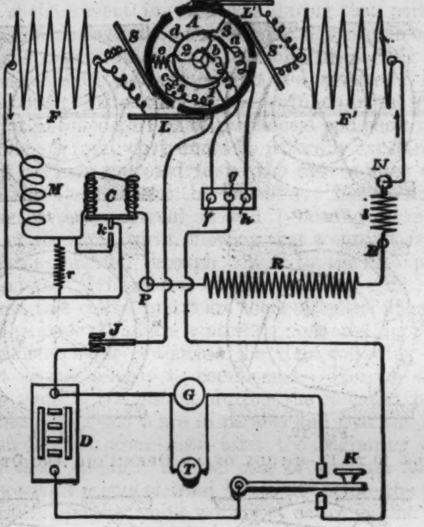


Fig. 2.

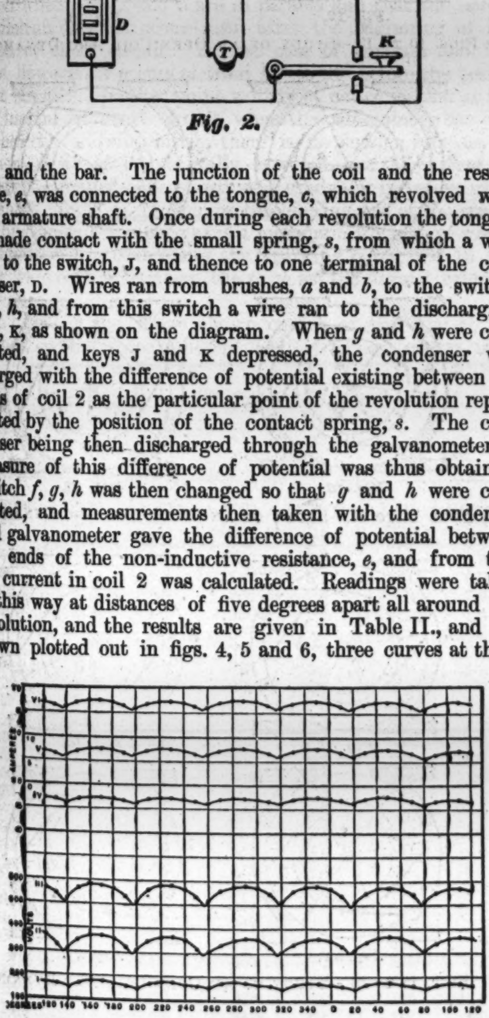


Fig. 3.

Turning, now, to the results obtained in fig. 3, curve I. represents the difference of potential at the terminals of the dynamo throughout the revolution under a light load, and curve IV. is the corresponding current. Curve II. is the potential for medium load, and curve V. the corresponding current, while curves III. and VI. represent the potential and current at full load. It will be noticed that the curves for medium and full loads are practically alike, while the curve for light load differs slightly in its character and is less symmetrical, and its minimum points occur slightly later than in the other curves. The curves of current and potential are practically alike, as might be expected since the self-induction of the external circuit was little or nothing. The curves are all of them about such as would result from a closed coil armature with a six-part commutator. It may be well to remark that in taking the observations for these curves closer readings than are shown were taken near the minimum points, so as to be sure these points were correctly placed.

These curves show that the external current is continuous and much steadier and more uniform than is usually supposed.

Referring to fig. 4, we find that the state of affairs in a single coil is quite different from that at the terminals of the dynamo. Curve I. represents the difference of potential at the ends of the coil throughout the revolution, and curve II. is the current in the same coil during the revolution. The curves shown in fig. 4 were taken with a light load. Figs. 5 and 6 show curves taken with medium and with full loads. For some unknown reason it was found impossible to get accurate readings for the current at full load, and so no

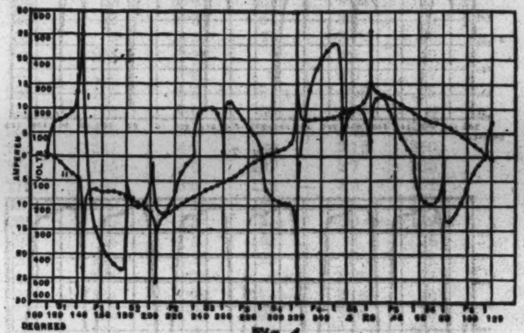


Fig. 4.

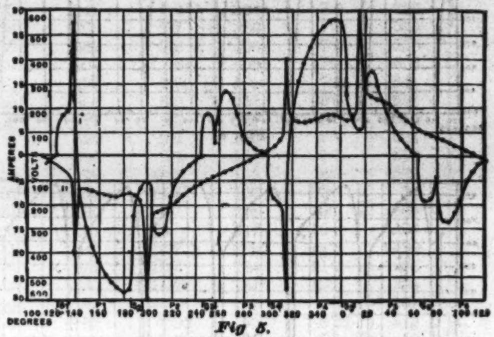


Fig. 5.

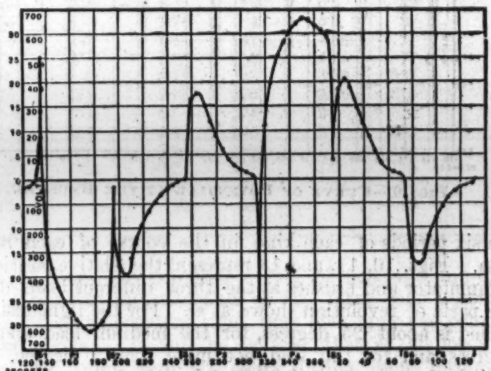


Fig. 6.

current curve is given in fig. 6. It is probable, though, from the similarity of the current curves at light load and at medium load, that the current for full load differed very much from the other two.

It will be noticed that at all loads the potential changes sign no less than six times during the revolution, and falls to zero, or almost to it, as often as twelve times, while the current reverses but twice during the revolution, and for the most part goes through very gradual changes. At the bottoms of the figures are lines of spaces showing the positions of the armature during the part of the revolution represented by the curves above them. s_1, s_2, s_3, are the periods of short circuit, and p_1, p_2, p_3, &c., are the periods during which two coils are usually supposed to be in parallel with each other and in series with the third coil. There are six periods of each kind in the course of each revolution. Figs. 10, 14, and 18 represent the relative positions of commutator and brushes at the three different loads during the parts of revolution shown at s_1. For the light load this period is about 25 degrees, for the medium load about 10 degrees, and for full load not more than 1 degree. The periods shown are not the *actual*, but the *apparent* periods of short circuit, as it would seem to be from the positions of the commutator and brushes. The *actual* periods of short circuit are somewhat longer, owing to the conductivity of the spark, and last until the spark is blown out. The exact point of the revolution represented by figs. 10, 14 and 18 is the point 130 degrees, as marked below the curves. Figs. 11, 15 and 19 represent the positions of the brushes and commutator for the parallel periods, p_1, or to give the exact position shown, 160 degrees. Figs. 12, 16 and 20 represent the second short circuit, s_2, and figs. 13, 17 and 21 show the second periods of parallelism, p_2, or 220 degrees. In all of these figures the relative positions of the coils and poles of the dynamo are also shown, the coils being numbered 1, 2, 3, just as they are on the dynamo. During the entire period represented by each four figures as above, the armature has turned through 120 degrees, or one-third of the revolution; and if we now consider the position of coil 2 changed to that of coil 1 in each figure, our figures will then represent the next third of the revolution. If coil 3 is supposed to occupy the position of coil 1, we shall then have the remaining third of the revolution.

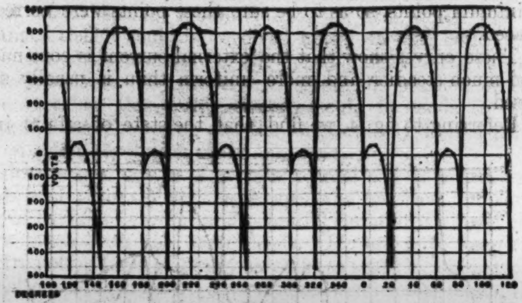


Fig. 7

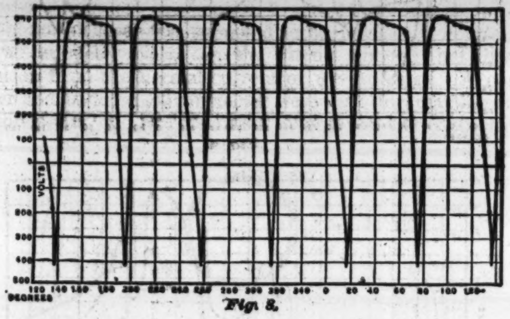


Fig. 8.

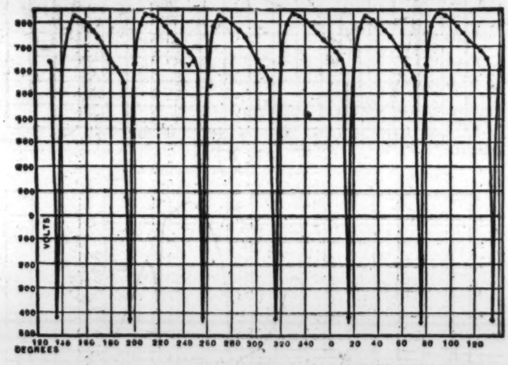


FIG. 9.—CURVE OF POTENTIAL AT THE BRUSHES.

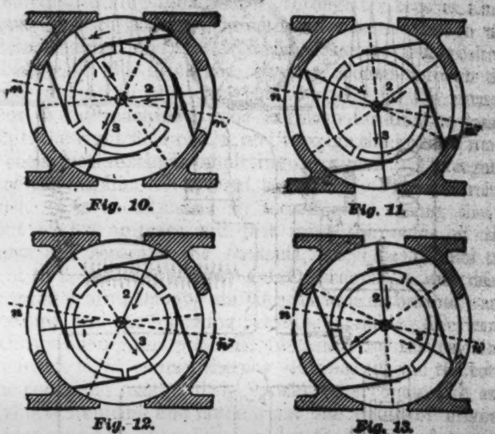


Fig. 10. *Fig. 11.* *Fig. 12.* *Fig. 13.*

FIGS. 10 TO 13.—STUDY OF AN OPEN COIL ARC DYNAMO.

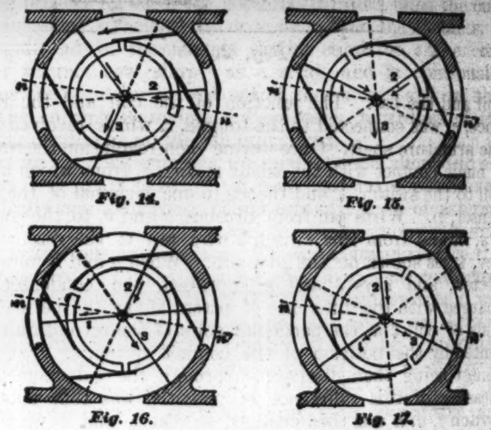


Fig. 14. *Fig. 15.* *Fig. 16.* *Fig. 17.*

FIGS. 14 TO 17.—STUDY OF AN OPEN COIL ARC DYNAMO.

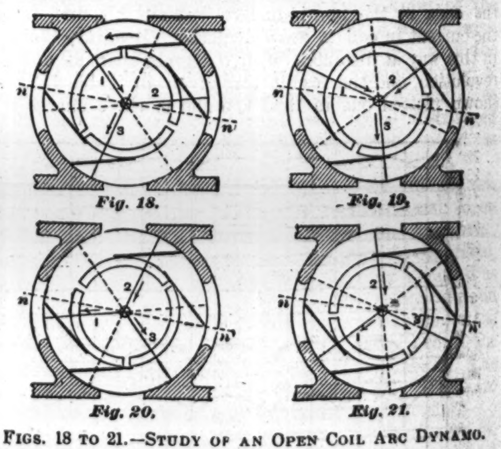


Fig. 18. *Fig. 19.* *Fig. 20.* *Fig. 21.*

FIGS. 18 TO 21.—STUDY OF AN OPEN COIL ARC DYNAMO.

It will be noticed that the more sudden and violent changes of potential occur just as the spark is forming and being broken at the front end of the commutator bar.

In examining these curves of potential it should be remembered that they represent the *difference* of *potential* at the ends of the coil and *not* the E.M.F. developed in the coil during the revolution. The sudden and marked changes in current which are shown at certain points of the current curves are selected from a number of readings which showed great variation. In some cases the reading had an opposite value from that shown in the curve, and it seems probable that, all things, considered, the average value of these points should be very little, if any, different from the others, and the whole should form a smooth curve without any very sudden changes. In figs. 10 to 21 the arrow shows the direction of the current in each coil during that particular part of the revolution represented by the figure. In each of these figures a neutral line, *n n′*, is shown, in passing which the current in each coil becomes zero and reverses. It will be noticed that the direction of the currents in the various coils for the so-called periods of parallelism and short circuit is quite different from what would be naturally expected and from what has been supposed to be the case in most of the descriptions of the action of this machine. For instance, in fig. 11 we have the current in coil 1 flowing *toward* the junction of the three wires, showing that a current is flowing from the junction through coil 3 to the left pair of brushes and back through coil 1 to the junction again, or, in other words, that coils 1 and 3 are short circuited upon each other. This state of affairs continues, with the light load, until commutator bar 3 touches the right following brush and short circuit period, s_2, commences. Thus it will be seen that there is no instant during the so-called parallel period when coils 1 and 3 are in parallel and that the *actual* parallelism does not occur until after the beginning of the period of short circuit. In the case of medium and full loads, however, it occurs at from 10° to 20° before the period short circuit. Another point worthy of notice is, that at the first instant of short circuit, when the commutator bar just touches the following brush, there is no sudden increase of current, as would be naturally expected, but the current in the short circuited coils slowly and gradually increases until the short circuit is broken by the blowing out of the spark, at which instant the current is a maximum in the coil whose commutator bar is opposite the sparking point, and in the other two coils it is about the same as the normal external current.

In figs. 7, 8 and 9 are shown curves of potential at the brushes, at the three different loads. These curves were obtained from the potential curves of figs. 4, 5 and 6, by adding together the potentials of the three coils according to their relative positions, and thus obtaining the potential at the brushes. It will be noticed that at all loads the curves fall below zero six times during each revolution, and that the difference in area and consequent effective E.M.F. is obtained more by the widening out of the curves than by increase in height. This is what we ought to expect from the change in duration of the short circuit periods. A comparison of these three curves of potential at the brushes with the three curves of potential at the terminals of the dynamo will give one a good idea of the remarkable steadying power which magnets such as the fields of this dynamo exert upon an intermittent current. No further explanation is needed of the fact that this dynamo will not work

TABLE I.—EXTERNAL CURVES.

	Light load.		Medium load.		Full load.	
Degrees.	Volts.	Ampères.	Volts.	Ampères.	Volts.	Ampères.
120	166	6·8	362	6·8	561	6·8
130	162	7·0	328	6·5	546	6·3
140	150	6·2	308	5·9	516	5·9
150	165	6·9	337	6·7	561	6·6
160	172	7·0	362	7·0	573	7·2
170	176	7·4	360	7·4	570	7·4
180	168	6·8	352	7·0	563	6·8
190	158	6·6	316	6·4	526	6·3
200	146	6·1	294	6·0	509	5·9
210	168	6·9	336	6·9	561	6·8
220	178	7·4	352	7·0	571	7·4
230	176	7·2	360	7·1	566	7·0
240	162	6·6	350	7·0	553	6·6
250	160	6·3	308	6·3	524	6·1
260	150	6·1	305	6·2	516	5·9
270	168	6·8	336	6·7	558	6·8
280	178	7·2	350	7·0	568	7·2
290	170	7·0	354	7·1	566	7·0
300	162	6·8	352	7·0	561	6·8
310	160	6·5	313	6·4	540	6·3
320	148	6·2	308	5·8	505	5·9
330	168	6·9	334	6·5	.554	6·6
340	176	7·4	347	7·0	571	7·4
350	174	7·4	352	7·5	568	7·2
0	166	6·8	352	7·1	564	6·8
10	162	6·7	326	6·4	536	6·6
20	148	6·1	308	6·0	495	5·7
30	168	6·8	342	6·8	546	6·6
40	176	7·2	360	7·2	563	7·0
50	178	7·4	365	7·3	568	7·2
60	168	6·9	362	7·1	561	6·8
70	160	6·6	345	6·7	546	6·3
80	152	6·3	305	5·9	514	5·9
90	162	6·6	336	6·3	546	6·8
100	176	7·3	360	7·0	568	7·2
110	174	7·2	365	7·2	568	7·2

TABLE II.—INTERNAL CURVES.

	Light load.		Medium load.		Full load.	
Degrees.	Volts.	Ampères.	Volts.	Ampères.	Volts.	Ampères.
120	140+	·28–	13–	1·31	33–	
125	149	1·43	0	2·2	24	
130	160	2·56	170+	3·0	15	
135	173	3·71	190	3·25	500+	
140	268	4·28	549	15·0	232–	
145	500	30·0	107–	6·5	368	
150	180–	7·4	292	7·0	445	
155	290	7·0	374	7·2	503	
160	368	7·5	445	7·6	543	
165	409	7·5	490	7·85	580	
170	441	7·6	520	8·15	613	
175	464	7·7	549	8·5	627	
180	173	7·75	560	7·7	607	
185	190	9·2	555	7·3	582	
190	202	9·75	255	8·0	545	
195	190	10·5	130	9·3	37	
200	110	11·1	107	30·0	362	
205	190	26·0	296	12·1	395	
210	235	12·7	320	11·3	325	
215	202	12·0	295	11·1	263	
920	145	10·6	170	10·3	196	
225	65	10·0	105	9·22	137	
230	35	9·3	51	8·1	95	
235	3	8·5	24	7·1	70	
240	175+	7·75	9	6·3	40	
245	192	7·0	0	5·6	27	
250	198	6·5	181+	4·96	18	
155	178	6·0	50	4·25	0	
260	233	5·5	199	3·68	333+	
265	221	4·7	269	3·12	350	
270	195	4·0	237	2·7	303	
275	155	3·0	178	2·2	232	
280	120	2·3	80	1·5	170	
285	90	1·3	55	1·0	119	
290	35	·5	35	·2	76	
295	140–	·28	20	·5+	51	
300	175–	·75+	6+	1·31+	33+	
305	184	1·25	174–	2·18	30	
310	190	1·75	195	3·06	15	
315	193	2·6	549	20·0	500–	
320	580	30·	150+	7·6	220+	
325	149+	7·2	304	7·0	390	
330	276	7·7	380	7·0	505	
335	362	7·6	450	7·3	555	
340	408	4·64	502	7·6	606	
345	437	7·78	535	7·85	641	
350	462	8·0	558	8·5	650	
355	173	8·6	566	8·6	652	
0	122	9·2	555	7·7	631	
5	190	9·9	256	7·3	610	
10	199	10·5	155	8·3	579	
15	149	11·4	107	30·0	74	
20	60	0	275	13·5	368	
25	241	13	347	12·2	407	
30	247	12·7	288	11·6	380	
35	199	12·4	224	11·2	285	
40	140	11·7	161	10·6	235	
45	83	10·8	107	9·22	167	
50	36	9·96	60	8·22	113	
55	9	8·94	35	7·1	59	
60	158–	8·25	14	6·3	39	
65	180	7·76	4	5·6	27	
70	197	7·41	187–	4·96	21	
75	174	7·03	180	4·25	77+	
80	142	6·45	83	3·68	331	
85	263	5·75	270	3·12	349	
90	230	5·0	274	2·7	316	
95	191	4·4	240	2·2	245	
100	127	3·22	186	1·5	165	
105	64	2·2	107	1·0	113	
110	23	1·61	61	·44	76	
115	9	·29	29	·5–	43	

as a separately excited machine. The whole set of curves will serve to illustrate some of the very remarkable effects of armature and field reactions, and any one sufficiently interested to make a detailed study of them might possibly succeed in bringing out a number of curious and interesting, if not useful, results.

It is to be regretted that time did not permit the measurement of the exact electromotive force developed in a separate coil of the armature, as distinct from the difference of potential at the ends of the coil, and also the measurement of the changes of magnetism occurring in the fields of the dynamo. With the help of this additional data a very complete study of the internal actions of the machine might have been made, and possibly results might have been obtained which would throw useful light upon the interesting subject of armature reactions. The writer hopes at some time in the near future to make a further study of the machine in this respect and to present any further data obtained in this way as a supplement to this paper.

TELEPHONY IN AUSTRIA.

THE statistics which have just been published by the Austrian Post and Telegraph Department show that a considerable development in telephony took place in 1889. During that year new State telephone services were opened in fifteen towns. The interurban line, Aussig-Teplitz, was extended to Brünn, and the exchanges in Karbitz, Mariaschein, and Dux were connected with it. On the 18th September the Vienna-Prague service was inaugurated, and a charge of one florin was instituted for three minutes' conversation. In case, however, of important messages, anyone paying three florins has the preference of communication. The subscribers to the Vienna Private Telephone Company and to the Telephone Company of Austria in Prague were permitted to make use of the State lines. As compared with the previous year, no alteration in the charges for conversation occurred in 1889, the rates ranging from 20 kr., or 4·67d. for five minutes in the same locality, to 1 fl. 50 kr., or 36·17d. for interurban communication on the longest line, Brünn-Wiener-Neustadt-Neunkirchen-Reichenau. The general position of the State and private telephones at the end of 1888 and 1889, was as follows :—

	1888.	1889.
Town networks	28	... 40
Groups of networks	20	... 35
Telephone lines (miles) ...	1,461	... 2,021
Telephone wires (miles) ...	10,434	... 16,338
Exchanges	24	... 42
Call offices	41	... 46
Subscribers	4,804	... 6,420
Telephones	5,035	... 6,610

Of the total length of cable and wire (16,338 miles), 2,318 were worked by the State, and 14,020 miles by private companies. Vienna ranked first in length of cable, Prague second, Graz third, Trieste fourth, Brünn fifth, and Reichenau sixth. The number of subscribers to both private and State lines increased from 1,242 in 1883, to 1,973 in 1884, to 2,519 in 1885, 3,250 in 1886, 3,868 in 1887, 4,804 in 1888, and to 6,420 in 1889. In this respect Vienna took the lead with 2,121 subscribers, Prague was second, with 788, and Trieste third, with 542. The augmentation in the number of communications, including telephonically transmitted telegrams, is shown in the following table :—

Year.		Number.
1884	... ...	1,883·393
1885	... ...	2,557·093
1886	... ...	3,846·048
1887	... ...	4,918·808
1888	... ...	6,032·467
1889	... ...	7,975·884

As compared with 1888, the number of subscribers in 1889 increased by 25 per cent., the length of wires by 51 per per cent., and the number of communications by 31 per cent. The *personnel* of the telephone service advanced from 289 in 1888 to 414 in 1889 ; the receipts from 418,661 florins to 623,424 florins, and the expenses from 737,965 florins to 1,397,378 florins. As regards the present position of telephony, Vienna maintains the first place in so far as the extent of the service is concerned, but it is said to be surpassed in the number of communications by Prague, Linz, Trieste, Brünn, Lemberg, Reichenberg and Pilsen.

RESEARCHES ON THERMO-ELECTRICITY.

THE *Comptes Rendus* of the French Academy of Science of May 25th contains a further contribution to our knowledge of thermo-electricity from MM. Chassagny and Abraham. The series of experiments upon which these physicists have been engaged commenced nearly a year ago, and papers were read upon them before the Academy and published in the *Comptes Rendus*, Vol. cxi., pp. 477, 602, 732.

The main object of these researches is the accumulation of data respecting the electromotive force of various thermo-electric couples. The method of measurement resorted to was the "method of opposition ;" the metals were used in the form of wires carefully insulated and soldered at one end into a small mass of copper, this precaution being taken in order to ensure the warm junctions being at the same temperature ; the cold junctions were placed in melting ice. The temperature of the bath was taken by means of a mercury thermometer of the Tonnelot type, and the results were reduced to the scale of the hydrogen thermometer by means of tables furnished by the *Bureau International des Poids et Mesures* where the thermometer was standardised.

In studying the iron-copper couple the following result was arrived at, namely :—That a parabolic formula of two terms is quite insufficient to rely upon in referring the values of the electromotive force to the corresponding temperatures of the hydrogen thermometer ; the temperatures calculated by means of such a formula for 0°, 50°, 100° present errors of 0·12° at 25° and + 0·13° at 75°.

This fact is, however, not only observed in the case of the iron-copper couple, it has been noticed for all the couples which Chassagny and Abraham have examined, and the errors exhibit a remarkable agreement.

The following table shows the values of the electromotive forces observed :—

Couples.	$E_0^{100°}$.	$E_0^{75°}$.	$E_0^{50°}$.	$E_0^{25°}$.
Iron-copper... ...	0·0010932	0·0008649	0·0006048	0·0003155
Iron-rhodioplatinum	0·0008951	0·0007089	0·0004961	0·0002591
Iron-silver	0·0011230	0·0008856	0·0006174	0·0003211
Iron-platinum ...	0·0016851	0·0012789	0·0008599	0·0004321

The necessity of only employing homogeneous wires and the dependence of the electromotive force of the couple on the temperature of the junctions, has rendered the measurement in the case of nickel impracticable.

In calculating for each of the above couples an expression of the form

$$E_0^t = a t + b t^2$$

which gives at 50° and 100° the values observed, it is found that according to this formula the electromotive forces measured at 25° and 75° correspond to the following temperatures :—

Couples.	Temperatures.	
	degrees.	degrees.
Iron-copper	24·880	75·130
Iron-rhodioplatinum	24·885	75·135
Iron-silver	24·870	75·135
Iron-platinum	24·870	75·135
Means	24·875	75·135

The numbers in each of these columns are approximately as identical as the readings on the mercury thermometer.

It seems that when the scale of the hydrogen thermometer is adopted, the course of any one of these couples is mathematically not parabolic, and that their thermo-electric powers are represented not by straight lines but by curves having their concavities turned towards the axis of the temperatures. If, however, the scale be adopted in which the temperatures 0°, 24·875°, 50°, 75·13°, 100° correspond to the temperatures 0°, 25°, 50°, 75°, 100° of the hydrogen thermometer, then the curves representing the electromotive forces of all these couples between 0° and 100° become exactly parabolic, and those representing their thermo-electric powers become straight lines.

It may be remarked that these results apply equally to six other couples, which may be formed by grouping the metals employed differently ; the results obtained with them have been used to control the previous results.

Messrs. Chassagny and Abraham have been carrying on these researches upon thermo-electricity at the physical laboratory of the Ecole Normale Supérieure.

ALEXANDER BESSOLO, THE ORIGINAL INVENTOR OF THE TRANSMISSION OF FORCE BY ELECTRICITY, AND OF AN ELECTRIC RAILWAY WITH OVERHEAD CONDUCTOR.

By A. M. Tanner.

For some time it has been known to the writer that a French patent, issued in the name of Henry Gilbee on the 16th day of January, 1855, No. 22,114, contains a description of a method of transmitting force by electricity, and the employment of electric motors for the propulsion of cars on railways, either the track rails or an overhead conductor being used to convey the current. Upon examining the original documents of the patent in question it soon became apparent that some person other than the patentee was the inventor of the various forms of electric motors and special uses thereof as described in the patent and its two certificates of addition. This opinion was strengthened by the fact that an English patent, No. 148, of 1855, issued in the name of de Fontaine-Moreau, and substantially embracing the subject matter of the first certificate of addition of the French patent of Gilbee, is stated to be "a communication." As Gilbee figured in the original French documents as the *employé* of the patent agent who took out the English patent, it became necessary to find the real inventor of the subject-matter set forth in the French patent. Lithograph drawings filed with the patent application were undoubtedly made in Italy, as they bear the names of the Italian draughtsmen and address of the lithographer in Turin. A slight clue as to the identity of the inventor was obtained when the name "Bessolo" was noticed written in lead pencil on the patent document. The writer then remembered that a French engineer, several years ago, stated in a discourse on the transmission of force by electricity that one Bessolo, and not Gramme, was the discoverer of the transmission of force by electricity. The source of information, however, was not given, and it was thought by the writer that no published description existed of the Bessolo invention.

The pencil-written name on the French patent was taken up as a clue, and enquiry in various places soon revealed the real facts in the case, and the writer was permitted to see a document on file in the secret archives of the Conservatoire Nationale des Arts et Metiers.

The following is a copy of the document in question, which is said to have been deposited by Alexander Bessolo on the 26th day of October, 1883.

[COPY.]

I, Henry Gilbee, of No. 9, Sackville Street, Piccadilly, London, son of the late William and Charlotte Gilbee, born in London in the year 1831, do solemnly and sincerely declare that in the year 1855, when I was employed in the Patent Office of the late Peter Armand Le Comte de Fontaine-Moreau, brother-in-law of my mother, at Paris, 39, Rue de l'Exchiquier, I took out, by order of him, in my name, under the title of "Systeme de moteur electrique," a French patent dated January 19th, 1855, and also a Belgian patent dated January 22nd, 1855, which invention I fully believe Mr. Bessolo (Cavaliere) Alexander, late Peter, born at Corea, Italy, at present retired major, to be the inventor and author, and I further declare that Mr. Bessolo, in the commencement of the year 1855, gave orders to the said Patent Office in Paris to take out the patents in the countries before mentioned under the title of "Moteur electro magnetique rotatoire à reaction entre le fer," for which purpose he sent the description and two lithographed drawings, marked A and B, and a special procuration to take out in my name French and Belgian patents, on the condition that afterwards I would transfer the said patents to him. I further declare that the sheets of drawings marked A and A′, B B′, have been respectively lithographed on the same stone as sheets A and B, and that I deposited them at the French and Belgium Patent Offices in order to confirm that I received the above from him. I further declare that I saw the autographic pamphlets marked C, and the two manuscripts marked D and E (the first was a copy) frequently in the hands of Mr. Bessolo between the months of May and July, 1855, at the said Patent Office in Paris, for the purpose of preparing the definite description. I therefore make this declaration to justify Mr. Bessolo as being the author of the said invention, and that I merely took them out by his procuration, and I make this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the statutory declarations October, 1835.

(Signed) H. Gilbee.

Subscribed and declared at the Mansion House, in the City of London, this 17th day of October, 1883.

(Signed) Henry Knight,
Lord Mayor London.

Here follow legalisations of the Lord Mayor's signature by the Italian Consul General at London, and then the Director of the Conservatoire des Arts et Metiers certifies that the copy of the affidavit left at his bureau is like the original seen by him.

Having now conclusively established the fact that Alexander Bessolo was the real inventor of the subject matter contained in the patent taken out in France in the name of Gilbee, I will now review the second certificate of addition of said patent, which in unmistakeable language contains a description of the transmission of force by electricity. I will give the description in the original as follows, viz. :—

Transmission à distance. Dans le cas ou l'on besoin du travail d'un moteur quelconque à une certaine distance de l'emplacement de ce dernier on emploiera la force dont on dispose à faire mouvoir directement une machine magneto electrique qui au moyen de fils télégraphiques communique le courant à une moteur électro magnetique. Ainsi dans le percement des montagnes on profiterait des chutes d'eau ou de vent pour mettre en mouvement une on plusieurs machines magnéto electriques qui communiqueraient leur courant à un moteur. Electromagnetique mis en rapport avec la machine ont il executant le percement et placée dans le galerie même.

It is needless to say that Gramme and his co-worker Fontaine cannot, in view of the foregoing description, maintain the claim that they were the first to propose the transmission of force by electricity at the Vienna Exposition of 1873. Another portion of the description in the second certificate of addition of the Bessolo patent, obtained through the procuration of Gilbee, will now be considered. Many uses of the patented electric motor are referred to, such as driving screw propellers, ventilating fans, aerial ships, and submarine boats, but the most important feature is where the propulsion of cars on railways is referred to. After disclaiming the use of batteries carried by the car, it is stated that "batteries are located at the different stations and the electric current from the same is conveyed to the electromotor locomotive by the rails, or by a conductor insulated from the ground and supported on poles in a manner analogous to telegraph wires, which might even be supported on the same poles. The adherence is ensured by the electromagnetic attraction exerted between the wheels and the rails, or by the solidity of pairs of wheels of one or several vehicles when they are connected by means of cords, chains or belts." The description is silent as to a travelling connection between the electric motor on the car and the overhead conductor; but obviously such a connection was contemplated by the inventor, and the description thereof was left out by inadvertence, and not because it was not understood that a travelling connection had to be provided between the overhead conductor and the motor on the car. It will, of course, be held that a published description, in order to defeat a patent, must be clear, and in such terms as to enable anyone skilled in the art to make and use the invention described. Viewed in this light, the French patent might not be sufficient to stand a judicial test as a bar to the validity of a patent claiming broadly the electric railway system with an overhead conductor and travelling connection supplying the current to the car motor. This article, however, is not a legal argument, and does not pretend to be anything but a review of the inventions of a meritorious inventor who had a clear conception of the transmission of force by electricity and a railway system with an overhead conductor in what has been termed the infant age of electricity. It has been ascertained by the writer, but not yet confirmed by personal investigation, that an Austrian patent, granted to Alexander Bessolo on the 3rd day of December, 1855, is for an electromagnetic motor, and applications thereof, in which is found a description of the travelling connection between the overhead conductor and the car motor.

P.S.—Since writing the foregoing article, the discovery has been made that *La Lumière Electrique*, of December 8th, 1883, contains an illustrated article concerning Bessolo's French patent. The subject, however, is not treated in the same way as by the present writer, and the bearing of the patent upon the transmission of force by electricity on railways is not brought into the foreground.

THE FIRST EXPERIMENTS OF THE ELECTRICAL RAILWAY WITH A VERTICAL TRACK.

[FROM OUR OWN CORRESPONDENT.]

IN your issue of November 15th, 1889, you published a complete and illustrated description of the Zipernowsky electric tramway with a vertical track. I am now enabled to report to you on the first trial of such a tramline at the Budapest Waggon Works, of the length of 250 metres and to send you some photographs illustrating the accomplishment of the project.

This trial line was designed to represent all the conditions which occur on a tramway and thus test the applicability of the system.

To this end there was laid down a curve of 90°, and of 20 metres radius, and further a counter-curve of 30 metres radius without a straight transition piece, as also a complete shunt consisting of two changes with a length of 42 metres between the points.

The trial line is level, but both in the straight parts and in the curve there are introduced short pieces with an incline of 20 in 1,000 (1 in 50).

As compared with the description which you published, some small modifications were made both in the line and in the car.

The upper structure of the line is already known from the description which you have published. You must remark, however, that in its present execution the surface which gives off the current is horizontal. The upper surface of the rails is also coated with a peculiar mass which insulates and also prevents metallic particles which might be accidentally introduced through the slit of the rails into the interior of the channel from occasioning a short circuit.

The running-rails weigh 23 kilos per metre and the guide-rails 10 kilos.

The upper structure was in part completely walled in, but in part merely screwed to the sleepers which are simply bedded in sand. This was done in order to observe the processes which take place in the channel during the journey.

As regards the construction of the car I must refer to the description which you published in November, 1889. But the most essential part of the car, *i.e.*, the plate extending through the slit of the running-rails into the interior of the channel consists of wrought cast steel of the thickness of 25—27 mm.

This plate carries at its lower end two guide rollers, fixed at 10 mm. from each other, which run on the guide-rails of the car. A little above these rollers there are sliding contacts on each side of the plate, each consisting of a double sledge with a steel contact piece. The latter constantly press upwards against the sliding surface of the current-rails.

The car, as it is well known, consists of two turning supports with a distance of 3 metres between the turning points. The sliding contacts are 8 in number, 4 on each current rail. By this arrangement the advantage is secured that if one pair of sledges should accidentally find no contact, the other pair takes up the contact at the distance of 3 metres, before or behind.

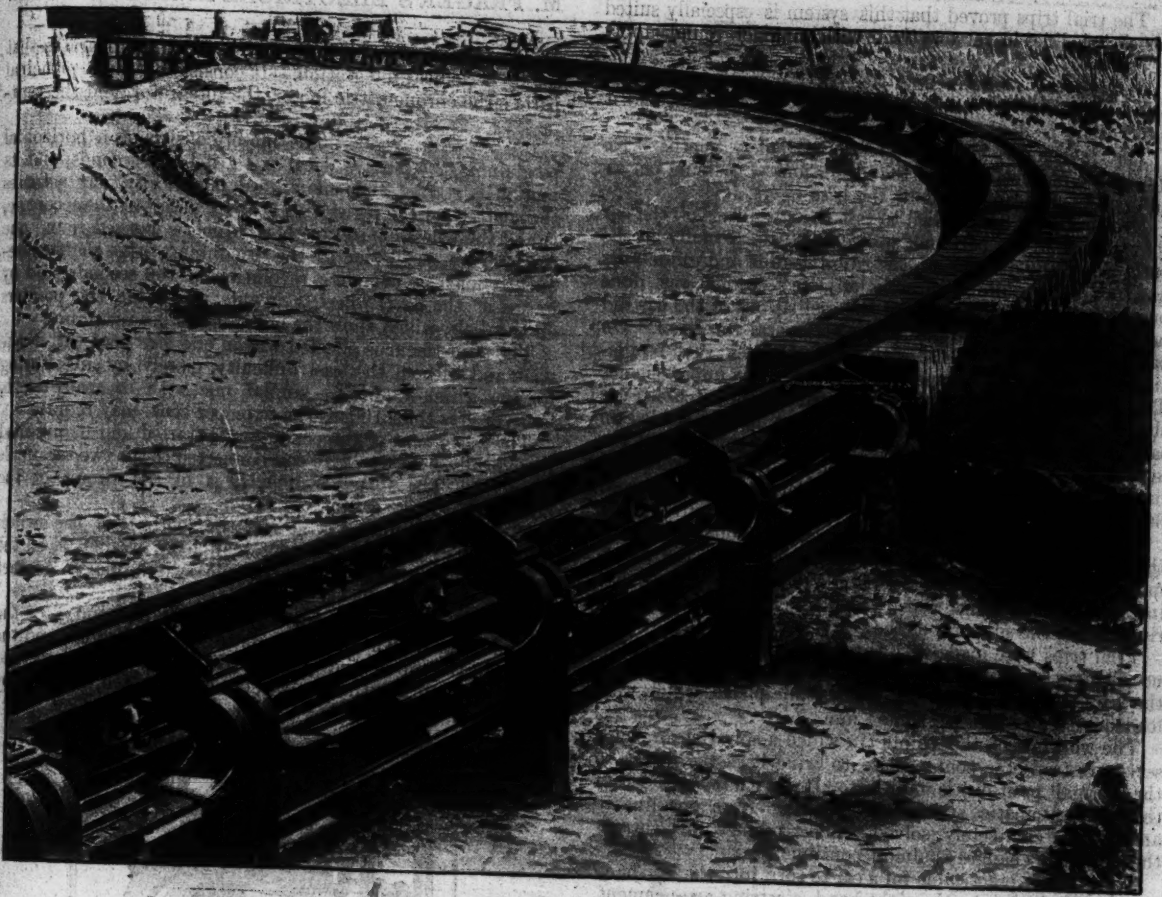
Each rotating support consists of two wheels, one only of which is driven by the electromotor. Hence the car has two running and two driving wheels.

A further deviation from the first model is that the wheels are now placed not obliquely but vertically.

The action of the motors upon the axles is effected by means of a worm and a worm wheel in such a manner that the worm is keyed upon the shaft of the electromotor, and the worm wheel is bolted upon driving shaft.

In order to reverse the worm its pitch is selected correspondingly high.

The box of the car is 1,600 mm. in breadth and 5,000 mm. in length, containing three compartments with 24 seats. The middle compartment is partitioned off, and there are besides, 6 seats at the front ends of the car. Here there is also a platform of 1,000 mm. in length, from which both electromotors can be attended to and regulated by means of a hand brake.



The trial trips proved that this system is especially suited for electric lines in narrow streets with an underground supply of current.

Both in the straight lines and in the curves and at the points a speed of 10 kilometres an hour was attained, and it could easily be doubled on a longer line.

The movements of the car are extremely gentle. No shocks are perceptible, and the operations of passing curves and points are scarcely felt by the passengers.

Measurements undertaken to test the steadiness of the car showed that in the parts not walled in, and especially at the parts where the distance of the running-rails and guide-rails had not been quite accurately adjusted (which was done purposely) the highest point of the oscillations of the car did not amount quite to 50 mm. in a horizontal direction. On other tramways, even those with a normal track, such oscillations are very frequent, and have not led to any improvement. The oscillations are chiefly occasioned by the circumstance that the structure was not walled in but merely bedded in sand, and that therefore the elasticity of the sand and of the legs of the chairs came into full play. At parts where the line was walled in and paved, the oscillations did not exceed 30 mm.

Vertical oscillations were not observed, probably because the car was built without springs. Nevertheless, the movements of the car were gentle, and vibrations generally felt in cars without springs were evaded by placing India-rubber rings under the supports of the car.

Trial trips were made with the car loaded on one side, but no changes were observed either in the upper structure or the cars, and especially not in the guide plates, which were loaded with 20 kilos. per square mm.

The working of the points (in which a spiral spring now serves instead of a counterpoise to bring back the points to the normal position) is faultless. It may now be asserted that an automatic system of changing from one line to another is completely solved. The passage of current through both changes is almost continuous.

To render it practicable for a car to turn into the left-hand track instead of into the right-hand, a setting arrangement, worked by hand, has been provided at the lower tongue of the point.

A NEW WAY OF MAKING CHLORATE OF POTASH AND TIN BY ELECTROLYSIS.

THE idea of this electrolytic process, which is due to Mons. Jobard, of Vincennes, is to manufacture chlorate of potash, and at the same time to prepare a by-product of sufficient value to pay the whole cost of working. It can be applied to the preparation of various substances; but here is an example of its use in which chlorate of potash and tin are proposed.

Stannic chloride is taken and dissolved into a neutral solution which must be concentrated; then a sufficient quantity of common salt (sodium chloride) is added.

The electrolysis is performed in a cemented vat. The electrodes are as follows: Anodes of graphite and cathodes of tinned iron. On causing the current to pass, metallic tin is deposited in a crystalline condition and chlorine is set free; the latter is passed into an ordinary chlorate of potash apparatus when it is used up. It is found convenient to heat the bath in order to facilitate the electrolytic action.

In working under the most favourable conditions possible, the loss of metal does not exceed 10 per cent. of the weight of the metal contained in the chloride, whilst the yield of chlorate of potash is about 25 per cent. lower than that which corresponds to the theoretical weight of the chlorine liberated during the electrolysis.

The process can be applied to other metallic salts; thus, if the chlorides of zinc, copper, &c., be employed, their metals can be economically precipitated.

Frager's Electric Energy Meter.—We fear that some slight difficulty will be experienced in reading the lettering on the blocks illustrating this apparatus with the text, but the meter will be readily understood from the letter-press alone.

M. FRAGER'S ELECTRICAL ENERGY METER.

M. FRAGER's meter belongs to the class of apparatus that act by periodical integration. It consists of three principal parts: the chronometric motor, the integrator, and the wattmeter.

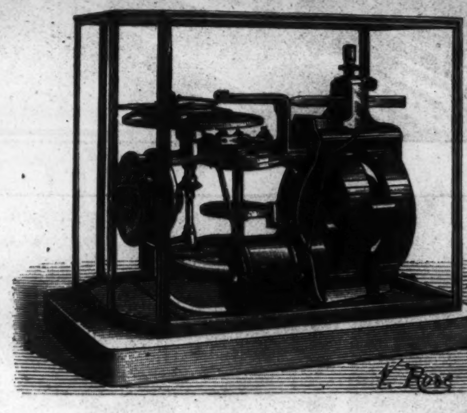
Chronometric Motor.—The motor consists of a horizontal pendulum, $j\ l\ h$, on a vertical axis; it beats seconds, and its motion is started and maintained electrically. It actuates the shaft, γ, of the registering gear by means of the eccentric, ν, and the wheel of 100 teeth, x, which is pushed round one tooth every oscillation of the pendulum; this shaft consequently makes a complete revolution in 100 seconds, and by means of the bevel wheel, λ, it puts in motion the pointers on the dials, which show the hours it has been running.

The adjustment is effected within one per cent. after one trial, and without the least difficulty, merely by substituting for the wheel, λ, another similar one with as many teeth, more or less than 100, as the error per cent. may require.

The movement of the pendulum is started and maintained periodically by a fine wire coil connected to the two terminals 1 and 2. The spring switch, c, is in the circuit of the bobbin a.

When the pendulum is at rest the tooth, ρ, of the switch takes up its position in the notch in loose washer, e, on the top of axle, and the spring of the switch makes contact at d.

When the current is turned on, the soft iron end, j, of the pendulum is drawn into the centre of the bobbin, and the pin, t, in the top of the axle moves the loose washer, e, and by doing so throws the tooth, ρ, out of the notch, and thereby breaks the circuit; when the current is thus cut off, the pendulum, under the influence of the spiral spring, s, flies back, and just when its other soft iron extremity, h, arrives at the mouth of the solenoid, the loose washer, e, allows the tooth, ρ, to enter the notch again, and contact is re-established, and the pendulum, being attracted in the opposite direction, acquires a further impetus with each simple oscillation. These repeated impulses would develop, if continued, oscillations much too large, but they are checked by the regulating washer, f. This washer, f, is mounted underneath e, but is also loose on the axle of the pendulum, and partakes of its movement by means of a tooth attached at right angles to the plane of e, free to move in a keyway in the side of f. This washer, f, also has a notch for the tooth, ρ, of the switch, but its movement in relation to the washer, e, is such that when the oscillations of the pendulum become too great the two notches do not correspond, and consequently the contact remains broken till the amplitude of the oscillation is reduced.

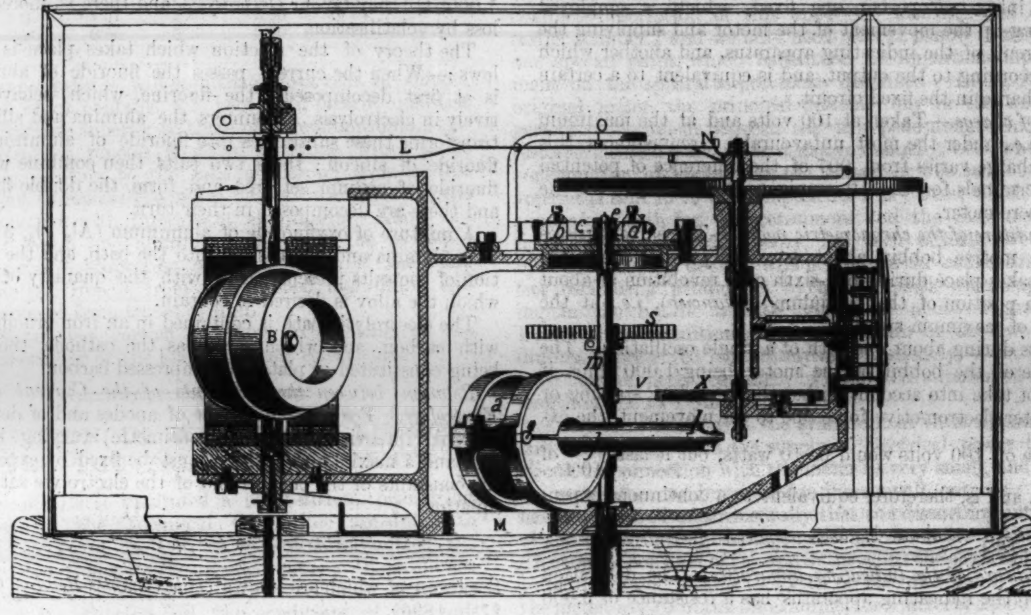


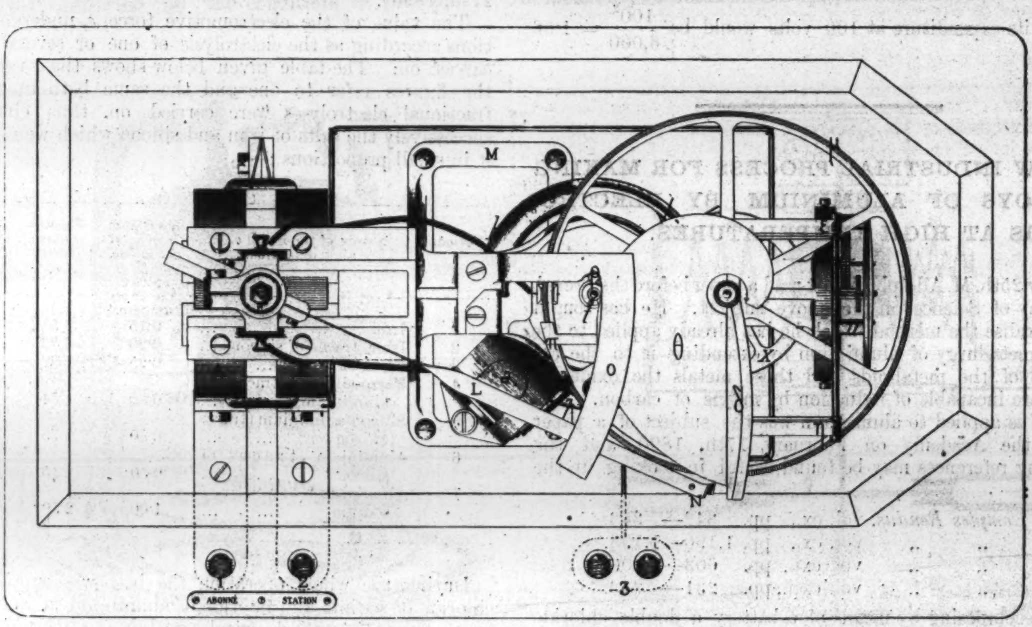
When the current is turned off altogether this oscillating movement ceases gradually, and the washers, moving through a smaller arc each successive oscillation, are brought into a position nearly symmetrical with the position of rest of the pendulum, the tooth falls into the middle of both notches, contact is established, and the instrument is ready to start again.

Integrating Apparatus.—The shaft γ, carries at the top a bar, δ, which at each revolution lifts the flexible needle, N, whatever position it may be in, and, in doing so, presses it against the bridge, O; when the bar has passed on and is free the needle falls on the cam, θ, and in pressing it down from its horizontal axle, εη, the tooth, π, engages in the wheel of 600 teeth, μ, and continues to do so until the cam has travelled so far that the needle leaves it.

The outline of this cam is such that for any position of the needle the angle through which the wheel, μ, moves is proportional to the watts in the circuit at the time.

The wheel, μ, advances every 100 seconds, an amount proportional to the watts indicated by the position of the needle at the instant when it is caught by the bar, δ.





These individual impulses are added up, as it were, and communicated to the dials, through a train of clockwork suitable to the units chosen, by means of the bevel wheel, λ, and thus the increase in the readings on the dials in a given time denotes the energy expended in the circuit during that time.

A large needle is fixed on the dial, which advances every 100 seconds a certain number of divisions; these divisions indicate in watt-hours the energy expended during that time. By multiplying the number of divisions passed over each time by 36, we arrive at the watts in the circuit, so that each division corresponds to 36 watts, or one 10-C.P. lamp approximately. This is an easy means of making a rough test of the meter by counting the lamps so registered, and comparing them with the lamps in use.

Wattmeter.—The wattmeter is composed of a fixed series circuit made up of two parallel coils, A A′, through which the current to be measured passes on its way to the lamps, and a movable bobbin, B, in parallel with the lamps. This movable coil is fixed on a hollow shaft through which passes the wire suspension, F F′, which being fixed rigidly at both ends, serves at the same time the purpose of a torsion spring.

When the current passes, this movable coil takes up a position of equilibrium between the force of mutual attraction between itself and the series coil and the resistance of the torsion spring; this position indicates the power in the circuit at the time, and the needle, L N, acts as the medium between the wattmeter and the dials, as we have seen.

All the instruments of the same size have the same parts and the same cam, so that their construction is absolutely identical, and all the parts are interchangeable, the only difference being in the number of teeth in the bevel wheel.

The adjustment is extremely simple, in that it may be immediately effected within 1 per cent. by changing the bevel wheel or the horizontal ratchet wheel, X. The maintenance is thereby infinitely simplified, in that any error may be at once rectified *in situ*.

D

They are able to register very small currents, as their sensibility at 0 is very great owing to the plane of the movable coil being at an angle of 45 degrees with that of the fixed coils.

Alternating currents.—M. Frager's energy meter may be adapted without any essential modification to alternating or undulating currents. The indications given by it are rendered as correct as possible, by virtue of the low coefficient of self-induction of the movable bobbin and its great resistance, which renders the time-constant of the shunt fine wire circuit very small, and consequently enables the corresponding factor of correction to be entirely disregarded in practice.

Expenditure of the apparatus.—This expenditure may be divided into two parts; one fixed, which is employed in keeping up the movement of the motor and supplying the shunt circuit of the indicating apparatus, and another which varies according to the output, and is equivalent to a certain loss of charge in the fixed circuit.

Loss of charge.—Taken at 100 volts and at the maximum output, *i.e.*, under the most unfavourable circumstances, this loss of charge varies from ·007 of the difference of potential at the terminals for the 10 ampère-meter to ·0004 for the 200 ampère-meter.

Expenditure of the chronometric motor.—The current passes into the motive bobbin about once every two seconds, the contact takes place during one-sixth of a revolution at about the mean position of the pendulum (*balancier*), *i.e.*, at the moment of maximum speed.

It lasts during about one-fifth of a single oscillation. The resistance of the bobbin of the motor being 1,000 ohms, if we do not take into account either the period of starting or the counter-electromotive force due to the movement, the expenditure of 100 volts would be 10 watts, but it lasts $\frac{1}{10{\cdot}4}$ of the time, and is, therefore, equivalent to a continuous expenditure of $\frac{10}{10{\cdot}4}$ = about 1 watt.

Expenditure of the indicating apparatus.—The derivation bobbin of the indicating apparatus has a resistance of 6,000 ohms; its expenditure at 100 volts would be $\frac{\overline{100}^2}{6{,}000} = 1{\cdot}66$ watts.

A NEW INDUSTRIAL PROCESS FOR MAKING ALLOYS OF ALUMINIUM BY ELECTROLYSIS AT HIGH TEMPERATURES.

ON May 25th, M. Adolphe Minet read a paper before the French Academy of Science on the above subject. He has sought to generalise the method which he has already applied to the electro-metallurgy of aluminium by extending it to the extraction of the metalloids and those metals the oxides of which are incapable of reduction by means of carbon. The method as applied to aluminium was the subject of a paper before the Academy on February 17th, 1890, and the following references may be found useful in looking up the subject :—

Comptes Rendus, vol. cx., pp. 342— 343.
„ „ vol. cx., pp. 1,190—1,193.
„ „ vol. cxi., pp. 603— 606.
„ „ vol. cxii., pp. 231— 233.

By decomposing by means of a battery a double chloride of aluminium and sodium which contained a little silica, Henri Sainte-Claire Deville obtained a fusible dark-grey crystalline substance which appeared to be a compound or alloy of aluminium and silicon. Under suitable conditions, the proportion of silicon in this alloy may be raised to 70 per cent.

When the alloy is attacked with hydrochloric acid a graphitoidal form of silicon is obtained, and if the alloy is poor in silicon, this metalloid is obtained in the form of a fine powder of which each grain possesses a crystalline structure; if, on the other hand, the alloy is rich in silicon, the metalloid is set free in the form of brilliant metal-like plates.

In the process to which Mons. Minet has during the past two years devoted so much attention, the aluminium salt employed by Deville is replaced by a mixture of sodium chloride (60 parts), and the double chloride of sodium and aluminium 30 parts. These substances are fused, and as soon as they melt five parts of silica and the same quantity of alumina is added. The silicon can then be obtained either in the free state or alloyed with aluminium.

The molten mixture only dissolves small quantities of alumina and silica; the greater part of these oxides remain simply in suspension.

The use of the fluoride is superior to that of the chlorides of aluminium, because at the high temperature (700°—1,000° C.) they favour electrolysis, and there is, moreover, no loss by volatilisation.

The theory of the reaction which takes place is as follows :—When the current passes the fluoride of aluminium is at first decomposed; the fluorine, which behaves positively in electrolysis, encounters the alumina and silica, and transforms these substances into fluoride of aluminium and fluoride of silicon; these two salts then combine with the fluoride of sodium set free and form the double fluorides, and these are decomposed in their turn.

A mixture of oxyfluoride of aluminium ($Al_2\ Fl_3,\ 3\ Al_2\ O_3$) with alumina and silica is fed into the bath, and the proportion of the salts present varies with the quantity of silicon which the alloy is desired to contain.

The electrolytic bath is contained in an iron crucible lined with carbon, and which serves as the cathode, the anodes being constituted of plates of compressed carbon.

Relation between the Constants of the Current and the Electrolyte.—For a given surface of anodes and of density of current (intensity per square centimetre) varying between zero and a maximum, δ, which must be fixed by experiment, the constants of the current and of the electrolyte satisfy the equation

$$\varepsilon = e + \rho\ I$$

the terms of which are known (*vide Comptes Rendus*, October 27th, 1890).

The value of the electromotive force, e, undergoes variations according as the electrolysis of one or several salts is carried on. The table given below shows these variations; the figures refer to one and the same bath upon which fractional electrolyses were carried on, thus eliminating successively the salts of iron and silicon which were found in it in small proportions :—

Periods.	Nature of the metal or alloy deposited.	Maximum density at the anode, δ.	Electromotive force, e.	Electrical resistance, ρ.
		ampere.	volt.	ohm.
1	Iron	0·15	0·54	0·0090
2	Iron (traces of silicon) ...	0·20	0·75	0·0093
3	Ferro-silicon	0·25	1·37	0·0089
4	Ferro-silicon (traces of aluminium)	0·30	1·54	0·0090
5	Silicon-aluminium (traces of iron)...	0·30	1·75	0·0080
6	Aluminium (traces of silicon	0·50	2·15	0·0085
7	Aluminium (traces of sodium	1·00	2·50	0·0087

During the whole operation the bath was supplied with chloride of sodium and fluoride of aluminium at such a rate as to maintain the electrical resistance, ρ, constant. The temperature was 850° C.

Industrial Application.—These experiments show that it is possible to extend this process to industrial applications, treating by electrolysis during fusion such minerals as red and white bauxite and the natural silicates of aluminium so as to produce not only alloys of iron, silicon, and aluminium, but aluminium chemically pure.

Mons. Minet has made some important experiments upon the strength of these alloys, the results of which are sufficiently interesting to warrant their quotation here. These experiments were carried out in Mons. de Ferriers's laboratory at the Conservatoire des Arts et Metiers.

Composition of the alloy.			Nature of the work.			
			Cast.		Forged.	
Aluminium, per cent.	Silicon, per cent.	Iron, per cent.	Charge at rupture, per sq. mm.	Stretching, per cent.	Charge at rupture, per sq. mm.	Stretching, per cent.
			Kg.		Kg.	
99·50	0·38	0·17	10·00	20·00	12·30	9·25
98·40	1·33	0·63	12·30	6·40	13·90	21·00
97·67	1·74	0·59	12·40	8·57	13·30	9·18
96·80	1·60	1·60	14·50	3·60	15·50	10·00
92·60	6·10	1·30	12·60	1·40	15·60	2·75
89·80	8·90	1·57	7·10	2·85	19·70	9·18
93·40	1·00	6·60	6·20	0·70	7·75	0·00

From these figures it will seen that alloys rich in silicon, such as that which contains 8·9 per cent., present qualities as regards fracture superior to those of pure aluminium.

The electrolytic process is stated by Mons. Minet to be capable of application to the salts of boron; it is in this case sufficient to replace the silica by boric anhydride in the double compound with fluoride of aluminium. Alloys are obtained of boron and aluminium in which the metalloid may exist in the proportion of 80 per cent. of the mass. Caustic soda will free it from uncombined aluminium and hydrochloric acid from traces of iron.

Mons. Minet has carried on these experiments at the chemical laboratory of the Ecole Normale Supérieure.

COMPETITION IN ELECTRICAL ENERGY METERS—THE PRIZE INSTRUMENTS.

THE City of Paris instituted a competition, placing at the disposal of the Technical Committee appointed to judge the merits of the various apparatus submitted the sum of 20,000 francs to be divided among the different competitors. In the first competition no apparatus was submitted satisfying all the conditions of the programme, and the committee could only distribute 7,000 francs as an encouragement, reserving the remaining 15,000 francs for a second competition. This second competition, which has led to surprising results, has just been terminated by the decision of which we gave a short summary in a preceding number.* We have now only to describe the apparatus which were deemed by the committee worthy of prizes, and we will begin with the two meters which shared equally, and in alphabetical order, the prize of 10,000 francs, awarded, according to the programme, to the inventor who should produce a meter giving complete satisfaction, and applicable to alternating as well as continuous currents; these are the electrical energy meters of Mr. Aron, of Berlin, and of Prof. Elihu Thomson, of Lynn (Massachusetts). Three other meters, two sent by M. Frager* and one by M. Marès,† have gained for their inventors the three prizes of 1,000 francs, completing the 15,000 francs at the disposal of the committee.

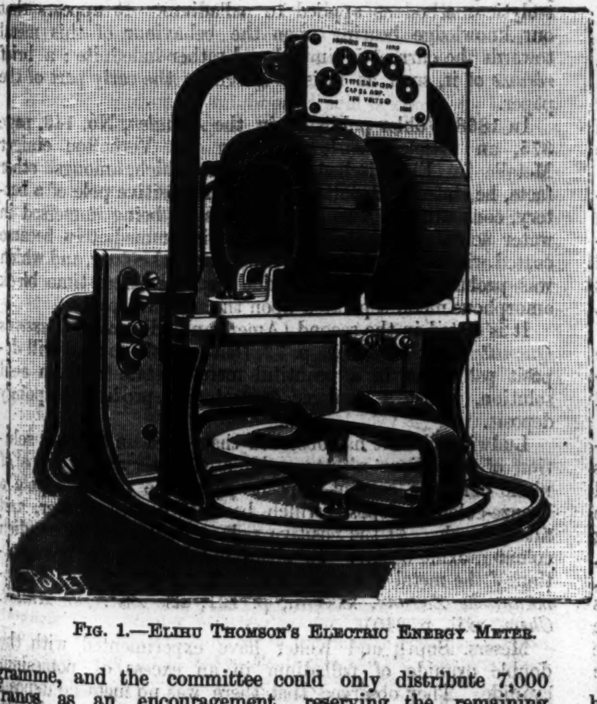
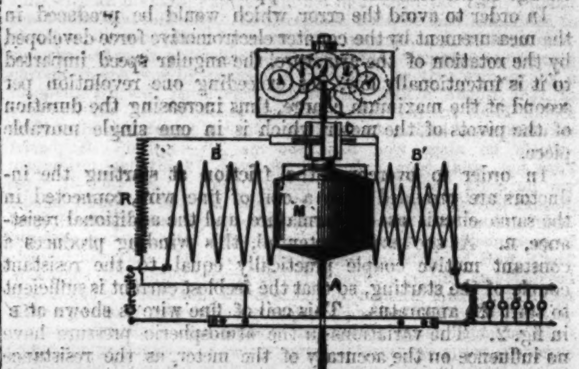


FIG. 1.—ELIHU THOMSON'S ELECTRIC ENERGY METER.

The Aron Meter.—M. Aron's apparatus is an electrical energy meter working on the continuous integration principle, and based on the different speed of two pendulums. A complete description of this apparatus has appeared in an earlier number,‡ and we only need refer to it now to mention one special point, which constitutes an important improvement on the apparatus previously described. In M. Aron's original meter, the principal difficulty lay in the want of perfect synchronism between the two pendulums, which registered either a positive or negative quantity, even when the consumption of energy by the consumer was *nil*. In the apparatus sent in to the competition this defect, which was a serious one both for the consumers and the company distributing the electrical energy, has been skilfully overcome by an ingenious device, which consists in connecting the two oscillating pendulums by a little slack wire, supporting in the middle a little weight of about 1 gramme. Under these conditions, the synchronism of the two pendulums is preserved indefinitely and absolutely, when it has once been properly regulated, by a suitable adjustment of the length of the two pendulums.

There is no doubt that the synchronism thus obtained is still maintained when the supply of electrical power to the circuit in connection with the meter is very small, and when the meter does not integrate for these small outputs; but it has been proved experimentally that the disturbing influence of the synchronising arrangement has no more appreciable effect on the constant of the apparatus when the electrical power to be integrated attains to $\frac{1}{200}$th of the maximum power of the meter, say 10 watts, for example, for a meter of 2,000 watts.



A, Arbor; M, Motor; B, B′, Field coils; C, Motor commutator; D, Copper disc electro-magnetic brake; R, additional resistance.

FIG. 2.

The Thomson Meter.—Prof. Elihu Thomson's meter belongs to the class of motor meters. It consists, in principle, of an electric motor, whose angular speed is, at each moment, in proportion to the power supplied to the circuit, with which it is connected. Under these conditions, a simple indicator of the number of revolutions performed by the axle of the electric motor integrates the electrical energy supplied, and enables it to be determined at any moment between two given periods, by taking the difference between the indications on the dials at the two periods in question. Although this idea has often been suggested before, and attempts have been made at various times to put it into practice, this is the first time that the problem has been solved by such simple methods, and that the carrying out of the theory has been so satisfactorily combined with the requirements of practice.

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* See ELECTRICAL REVIEW for June 5th.

* Described in this issue. † See REVIEW for Nov. 7th, 1890.
‡ See REVIEW for June 24th, 1887.

The apparatus shown in elevation in fig. 1, and theoretically in fig. 2, consists of three essential parts—an electro-dynamic motor, an electro-magnetic brake, and an indicator of the number of revolutions effected by the axle bearing the motor and the brake.

The motor consists of an inductive system, into which the principal current passes, and an armature of fine wire connected in derivation on the terminals of the canalisation, but with the introduction of a suitable resistance to the potential of the distribution, so that the intensity of the current passing through this derived circuit shall not exceed one-tenth of an ampère. Under these conditions, if we call I the intensity of the current passing through the inductors, and e the difference of potential maintained between the terminals of the fine wire, a motive couple is set in action between the movable bobbin and the fixed inductors, in proportion to $e\,I$, that is, in proportion to the electrical power to be integrated as a function of the time. The resistant couple is produced by the rotation of a flat disc, D, placed on the lower part of the motive axle between three magnets. The rotation of the disc develops in it induced currents, which render it a sort of electric generator acting upon itself in a closed circuit, and constituting a brake. The power thus absorbed being in proportion to the angular speed of the disc, there would be dynamic equilibrium when the motive couple is equal to the resistant couple, *i.e.*, when the angular speed of the disc is in proportion to the motive couple, and consequently to the power, $e\,I$. The mechanism for registering the number of revolutions has no special features, and is worked directly by an endless screw fixed to its upper part.

By the suppression of the iron in the armature and the inductors of the motor, the apparatus is rendered applicable to alternating as well as continuous currents, without any change in the constant of the apparatus.

In order to avoid the error which would be produced in the measurement by the counter electromotive force developed by the rotation of the armature, the angular speed imparted to it is intentionally low, not exceeding one revolution per second at the maximum charge, thus increasing the duration of the pivots of the meter, which is in one single movable piece.

In order to overcome the friction at starting the inductors are provided with a coil of fine wire, connected in the same circuit as the armature and the additional resistance, R. At the normal potential, this winding produces a constant motive couple practically equal to the resistant couple of the starting, so that the feeblest current is sufficient to start the apparatus. This coil of fine wire is shown at B′ in fig. 2. The variations in the atmospheric pressure have no influence on the accuracy of the meter, as the resistance to the air is very slight, in consequence of the shape and very low angular speed of the moving part.

The influence of the variations in the surrounding temperature is provided for in the construction of the apparatus by a very simple arrangement. The resistances connected in series with the armature are made of copper of the same quality as that used for the armature and the disc forming the brake. Thus, when, owing to a rise in the temperature, and consequently in the electrical resistance of the system, the motive couple decreases, the resistant couple decreases in the same proportion, because the electrical resistance of the disc increases, and this increase of resistance diminishes the intensity of the currents induced in the disc.

In order to calibrate the meter, we may vary either the resistance, R, which is in series with the armature, or the position of one of the magnets forming the inductors of the brake. The graduation is so arranged that the first needle indicating the number of revolutions makes one complete revolution for 1,000 revolutions of the armature, and as the meter is regulated so that each revolution of the armature represents a watt hour, the first dial indicates 1,000 watt hours, each division of this first dial 1 hecto-watt hour, and each of the succeeding dials indicates in the ratio of 10 to 1. The readings are then taken as in the ordinary gas meters.

The graduation is very simple and very rapid. We have only to make a mark on the disc and count the number of times it passes a certain point in a given time. Each apparatus may be in the same way checked at any moment and its accuracy ascertained. For this purpose it would be an advantage if the meter were enclosed, not in an opaque box of brass, as is the case with the model submitted to the committee, but in a box the front of which at least should be made of glass, so as to show clearly the simplicity of the apparatus, and also a great advantage which it has from the point of view of the interests of the consumer, viz., that of remaining completely motionless when the consumption is *nil*.

When the nature of the current passing through the apparatus is changed, the pointers of the meter go backwards and subtract with the same degree of accuracy, which fact may be turned to account in certain installations—those containing accumulators for instance. We may also remark that the meter is absolutely silent, and that its accuracy is practically perfect in every scale of consumption. All these advantages, and those which we have mentioned with regard to M. Aron's motor, justify the committee in dividing of prize of 10,000 francs between two instruments of equal excellence, both of which satisfactorily solve the problem of the practical measurement of the electrical energy supplied by central distributing stations.

E. HOSPITALIER.

La Nature, June 13th, 1891.

THE ELECTROLYTIC METHOD AS APPLIED TO PALLADIUM.

IN the issue of the *Chemical News* for May 29th there is a paper by E. F. Smith and H. F. Keller upon the electrolytic method as applied to palladium. It appears that our knowledge bearing upon the behaviour of this metal towards the current is limited and rather indefinite ; a brief *résume* of it, such as it is, is given in the early part of the paper.

In 1868 Wöhler published in the *Annalen*, No. 143, page 375, an article entitled "Ueber das Verhalten einiger Metalle im Elektrischen Strom," in which, amongst other facts, he stated that palladium as the positive pole of a battery, consisting of two Bunsen cells, on being immersed in water acidulated with sulphuric acid immediately became coated with a deposit having a bright steel colour, and which was probably palladium dioxide; at the same time black amorphous metal separated upon the negative pole.

It is stated in the second (American) edition of *Classen's Quantitative Electrolysis*, p. 72, that a feeble current will deposit palladium in a beautiful metallic state from an acid solution, whilst a stronger current will produce a spongy deposit.

Ludwig Schmidt has observed that from an aqueous solution of palladious nitrate, acidulated with a few drops of nitric acid, the current deposits upon the negative pole a bronze-coloured deposit, which becomes denser, darker, and finally black. At the positive pole a deposition of reddish coloured oxide occurs. In alkaline solutions the precipitation of the metal was much retarded (*vide Berg und Hüttenmäunische Zeitung*, xxxviii., p. 121, also *Zeit. für Annal. Chem.*, xxii., p. 240).

Messrs. Smith and Keller have experimented with the double cyanide of palladium in an excess of potassium cyanide. They observed that there was no metallic deposit until all the potassium cyanide had been converted into alkaline carbonates. The deposition was extremely rapid when a solution of palladious chloride in the presence of excess of potassium sulphocyanide was used. Palladammonium chloride in ammonium hydroxide was also tried, but the precipitation of the metal was incomplete. When the platinum dishes used in the electrolysis were first coated with silver, before being used, the deposition of the palladium appeared to be hastened.

The authors propose to study further the behaviour of ammoniacal palladium solutions when exposed to the action of the electric current, and an attempt will be made to redetermine the atomic weight of the metal by this method.

THE ELECTRICAL CONDUCTIVITIES OF ORGANIC ACIDS.

Mons. D. Berthelot, son of the Academician (Académie des Sciences), has recently been using observations on the electrical conductivity of acids in a most ingenious way, namely, in the determination of their basicity.

When an excess of acid is added to solution containing normal salts of monobasic organic acids consisting of a one-hundredth of a gramme-molecule per litre, an electrical conductivity is obtained agreeing with the value calculated on the assumption that no chemical change takes place.

In the case of formic acid, as a single exception, there is a reduction of the conductivity below the value calculated.

From these facts it may be deduced that acid salts of monobasic acids do not exist in solution at the degree of dilution specified. When an excess of alkali is added there is a reduction of conductivity of about 5 per cent. for the first equivalent, but the second equivalent has practically no effect.

Normal salts of bibasic acids behave differently. When an excess of acid is added the electrical conductivity is lower than the value calculated for a simple mixture, the reduction being due in this case to the formation of acid salts. But the actual values show that the acid salts undergo considerable dissociation into normal salt and free acid.

It is interesting to observe that all these results agree precisely with the conclusions deduced from thermo-chemical considerations and data.

The addition of excess of acid to normal salts of tribasic organic acids produce, as in the case of bibasic acids, an electrical conductivity lower than that calculated for a mixture of normal salt and free acid, but the effect is more prolonged than in that case owing to the existence of a second acid salt.

Berthelot has made measurements with tricarballytic, citric, aconitic and mellitic acids, these may be found in the *Comptes Rendus*, cxii., p. 335.

When the molecular weight of an acid is known its basicity can be readily determined by adding successive quantities of an alkali, and then determining the point at which the reduction of the electrical conductivity below that of a mere mixture ceases. But it must be remembered that the addition of excess of alkali to the normal salts also produces a small effect which ceases with the first equivalent in excess when the acid is monobasic, with the second when it is bibasic, with the third when it is tribasic, and with the sixth when it is hexabasic.

THE FARADAY CENTENARY.

A brilliant audience assembled on Wednesday afternoon at the Royal Institution to hear Lord Rayleigh deliver the first of the two lectures appointed in honour of the centenary of the birth of Michael Faraday, the second of which, to be given by Prof. Dewar, will be delivered next week. The Prince of Wales, President, was in the chair, and there were also present the Duke of Northumberland, Lord Morris, Sir G. Stokes, M.P., Sir H. Roscoe, M.P., Sir William Grove, Sir Frederic Leighton, Admiral Mayne, M.P., Sir F. Abel, Sir Frederick Bramwell (hon. secretary), the Lord Mayor and Lady Mayoress, the Dowager Lady Stanley of Alderley, Sir A. Geikie, Sir William Thomson, Dr. Meymott Tidy, Sir W. Bowman, Sir Benjamin Baker, Sir Joseph Lister, Sir F. Galton, Mr. Diggle, and Mr. Humphry Ward.

The Prince of Wales, who was cheered as he rose, said: Ladies and Gentlemen,—I can well remember that 22 years ago I had the high privilege of presiding at a meeting here, which was a very large one, and included many of the most eminent scientific men of the day. Among those present on that occasion, I remember, were the illustrious chemist, Prof. Dumas, Sir Edward Sabine, Sir Roderick Murchison, Sir Henry Holland, a very old personal friend of mine, Dr. Bence Jones, Dr. Warren de la Rue, and many others, who, I regret to say, have now passed away. The object of our meeting on that occasion was to select a suitable memorial to the memory of the great Faraday, the eminent chemist and philosopher, who, I may say, was also the founder of modern electricity. As you are all aware, the fine statue by Foley which is down in the hall below was, we thought, a suitable memorial to that great man. As for myself personally, I feel proud to think that in the days of my boyhood my brother and myself used to attend his chemical lectures here about Christmas time. We shall ever remember the admirable and lucid way in which he delivered those lectures to us, who were mere boys, and gave us thereby a deep interest in chemistry, which we kept up for many years, and which I had the opportunity of practising at the University of Oxford. I can only regret that I have not since had the time to pursue that interesting science. To-day is a memorable day, as this year we are celebrating the centenary of the birth of that great man, and I think that all of us have every reason to feel grateful that two such eminent men as Lord Rayleigh and Prof. Dewar should have consented to give lectures on the work of the great Faraday. I have only now to beg Lord Rayleigh to be so good as to give us his address.

Lord Rayleigh, who was received with cheers, said that the man whose name and work they were celebrating was identified in a remarkable degree with the history of that Institution. If they could not take credit for his birth, in other respects they could hardly claim too much. During a connection of 54 years, Faraday found there his opportunity, and for a large part of the time his home. The simple story of his life must be known to most who heard him. Fired by contact with the genius of Davy, he volunteered his services in the laboratory of the Institution. Davy, struck with the enthusiasm of the youth, gave him the desired opportunity, and, as had been said, secured in Faraday not the least of his discoveries. The early promise was indeed amply fulfilled, and for a long period of years, by his discoveries in chemistry and electricity, Faraday maintained the renown of the Royal Institution and the honour of England in the eyes of the civilised world. He should not attempt in the time at his disposal to trace in any detail the steps of that wonderful career. The task had already been performed by able hands. In their own "Proceedings" they had a vivid sketch from the pen of one whose absence that day was a matter of lively regret. Dr. Tyndall was a personal friend, had seen Faraday at work, had enjoyed opportunities of watching the action of his mind in face of a new idea. All that he could aim at was to recall, in a fragmentary manner, some of Faraday's great achievements, and if possible to estimate the position they held in contemporary science. Whether they had regard to fundamental scientific import, or to practical results, the first place must undoubtedly be assigned to the great discovery of the induction of electrical currents. He proposed first to show the experiment in something like its original form, and then to pass on to some variations, with illustrations from the behaviour of a model, whose mechanical properties were analogous. He was afraid that these elementary experiments would tax the patience of many who heard him, but it was one of the difficulties of his task that Faraday's discoveries were so fundamental as to have become familiar to all serious students of physics. Lord Rayleigh then illustrated the discovery, by such methods as were open to Faraday, without calling in aid the more elaborate resources of modern science. But, with all his skill, Faraday did not light upon the truth without great delay and difficulty. In December, 1824, he had attempted to obtain an electric current by means of a magnet, and on three occasions he had made elaborate, but unsuccessful, attempts to produce a current in one wire by means of a current in another wire, or by a magnet. He still persevered, and on the 29th of August, 1831, he obtained the first evidence that an electric current could induce another in a different circuit. On September 23rd he wrote to his friend, R. Phillips:—"I am busy just now again on electro-magnetism, and think I have got hold of a good thing, but can't say. It may be a weed instead of a fish that, after all my labour, I may at last pull up." It proved a very big fish indeed. Lord Rayleigh then, by a series of experiments with models, indicated, as he said, with substantial accuracy, all the phenomena of electric induction. He also illustrated the operation of Prof. Clerk Maxwell's differential gearing and of Huggins's gearing, and observed that it was a remarkable achievement of modern mathematics that all the results of these different experiments could be represented by the same equation. By a series of interesting experiments he illustrated the propagation of energy across intervening space by means of dielectric rings, and explained the decomposition of water by electricity, which could not be effected solely by a single Daniell cell, but could be done with the aid of self-induction. Faraday had always felt great uneasiness as to the soundness of contemporary views, and always experienced a fear of being misled by words. Having proved the complete identity of the electricity in lightning with that in the voltaic cell, he abandoned the term "pole" for "electrode," and considered the expression "electric fluid" a dangerous one. It was, indeed, a term which, as Maxwell observed, ought to be banished to the region of newspaper paragraphs. Diamagnetism was another subject for the researches of Faraday which had been more fully developed by Sir William Thomson. Lord Rayleigh then illustrated by some beautiful experiments the magnetisation of a ray of light, the full significance of which, not fully understood by Faraday, was realised to a great extent by Sir W. Thomson. His observations in acoustics were also of great value. Faraday had made one singular remark as to a particular formation of waves generated under the action of wind, which he had himself, after patient observation for half an hour or three-quarters of an hour, verified at a French watering place. He was disposed to doubt whether anybody else save Faraday and himself had ever noticed that phenomenon. But it was one thing to have discovered, and quite another to have verified the discovery once made. The philosopher had also made a number of minor observations of great value, and he was reminded of one by a recent lamentable accident caused by the breaking of a paraffin lamp. Faraday had shown a method of holding the breath for a prolonged time by means of successive deep inspirations and expirations, which, if practised, might have proved of saving worth on that sad occasion. The question had often been discussed what effect on Faraday's career would have been produced if he had been subjected to a mathematical training. They must all feel that they would not have wished him to be other than he was. But if the question must be discussed it would have to be admitted that, by such a training, he would have been placed in more thorough *rapport* with his scientific contemporaries. But mathematical training and mathematical capacity were different things, and it did not follow that Faraday had not a mathematical mind. In Prof. Clerk Maxwell's opinion Faraday had mathematical powers of a very high order, from which if he had devoted himself to that science, valuable and fertile methods might have been discovered by him.

Sir W. THOMSON, in moving a vote of thanks to Lord Rayleigh for his address, said that the Royal Institution was during the last part of Faraday's life and during the whole of his scientific career his home. The splendid results of Faraday's labours contributed in no small degree to the scientific glory of the nineteenth century, and helped to make it one of the most prolific periods in the world's history. Faraday was throughout animated solely by the love of knowledge. He freely gave his discoveries to mankind, and left it to others to turn them to practical and profitable account.

Sir G. STOKES, in seconding the motion, said that he had had the honour of a personal acquaintance with Faraday, whose single-minded devotion to knowledge for its own sake was beyond all praise.

The vote of thanks was cordially passed, and

Lord RAYLEIGH, in acknowledgment, said that it had been a great honour and a great responsibility which had been placed upon him. He remembered with gratitude the instruction which he had derived at Cambridge from Sir Gabriel Stokes, and felt deeply indebted to Sir William Thomson for all that he had learnt from his writings and his conversation.

Sir F. BRAMWELL then read the names of the distinguished foreigners upon whom the honorary membership of the Institution had been conferred. These included MM. Berthelot, A. Cornu, Mascart, Louis Pasteur; Prof. Bunsen, of Heidelberg; Profs. von Helmholtz, von Hoffmann, and Virchow, of Berlin; Profs. J. P. Cooke, Dana, and Simon Newcomb, of the United States; Profs. Canizzaro and Tacchini, of Rome; Prof. Thomsen, of Copenhagen; Prof. Thalen, of Upsala; Prof. Mendeleef, of St. Petersburg; Prof. Marignac, of Geneva; and Prof. Van der Waals, of Amsterdam. He also read a letter from Dr. Tyndall, in which the writer expressed his great regret at his inability in consequence of ill-health to be present, and said that, as Faraday receded from him in time, his character became to his mind more and more beautiful.

The new members of the Institution were then presented to his Royal Highness the President.—The *Times*

NOTES.

The New Franco-Danish Cable.—The second Franco-Danish cable, intended to duplicate that already laid between Oye, near Calais, and Fanoe, in Denmark, will be laid between July 18th and August 1st, between the same points, by which means a telegram will be able to be dispatched from Calais to St. Petersburg in 10 minutes, and *vice versâ*.

The Telephone in Sweden.—The Stockholm telephone subscribers are jubilant, the subscription price, fixed hitherto at rates varying from 112 fr. 25 c. to 175 fr. per year, having been tentatively reduced to 14 fr. 37 c. The rate for private communications has also been largely reduced, but the enormous difference made in the cases of subscribers seems too good to be true.

New Form of Zinc Element for Galvanic Batteries.—Messrs. David Mosely and Sons have recently introduced a new form of zinc element for galvanic batteries. In the case of a Leclanché zinc, the rod is built from a number of tubes, each being made of thin sheets. Each tube is amalgamated before being put together. It is claimed for these zincs that they are "without doubt a great improvement upon anything now on the market;" also that "a battery made up with the patent zincs is free from polarisation, owing to each concentric layer disclosing itself successively;" "no cost of maintenance, such as cleaning and scraping . . . . the zinc remaining free from chloride of zinc and crystals until completely done." In proof of these statements we have not a word of experimental corroborative evidence, and in the absence of this we express very grave doubts as to the value of the invention. In our own opinion we think the notion will prove to be an erroneous one, and in cases where the zincs are used in an acid solution, it is more calculated to ensure the destruction than the preservation of the metal.

Telegraphic Communication with Corsica.—The French telegraph administration is now engaged in remedying the insufficiency of telegraphic communication between Corsica and France, which was so noticeable last year during President Carnot's journey through that island, by the laying of a new submarine cable. Corsica will thus communicate with the continent by three cables. The first and oldest connects Macinaghio (Corsica) with Leghorn (Italy); the second was laid in 1880, and has one shore end at Bastia and the other at Antibes; the third cable, now being laid, leaves Ajaccio and lands at Toulon. The *Charente*, one of the two vessels belonging to the French telegraph administration for the laying and watching cables in the Mediterranean, has already laid a portion of the cable.

A New System of Submarine Telephone Cables.—According to the *Bulletin Internationale*, M. Picou has proposed the following arrangement:—The conducting portion of the cable would be divided into two parts, all along the whole length. That is to say, there would be two conductors of copper of a half-moon section, separated by a dielectric, and both enveloped within the same insulating material. The transmitter would be connected to one of the extremities of one conductor; the other extremity would remain free. The second conductor at the extremity adjacent to the free end of the first would lead to the receiving instrument; the other end of this remaining free, as with the first one. The receiver and transmitter would be connected direct to earth. The idea, we may mention, is by no means a new one, as the *Bulletin* imagines it is. We believe, moreover, that it has been demonstrated that the notion that any advantage is gained by the arrangement is entirely fallacious.

A New Electric Voting Apparatus.—We have been to see, says the *Indépendance Belge* of Saturday, at the Brasserie Flamande, where it was placed in a private room, the voting machine invented by M. Moreau, of La Louvière. This machine presents precisely the appearance of a small piano or an harmonium. As keyboard there is a series of buttons on which the elector must press to record his vote. The names of the candidates are classified by list. To each name a button corresponds. M. Moreau proposes to place the candidates' photographs opposite their names, so that the illiterate would know for whom they were voting. Under the keyboard is a cupboard, the case of the machine, in which is enclosed a tell-tale. Each button has its tell-tale, which registers the votes in units, tens, hundreds, and thousands. The electric batteries are placed under the case in place of the pedals. To approach the instrument the elector must get on a small rostrum, which suffices to establish the electric current, and he can then vote. The essential of this invention consists in the distribution of the electricity. M. Moreau has succeeded in regulating the machine according to the number of votes to be recorded by the elector. If the complete list of candidates is five, the instrument is regulated in such a manner that each voter cannot record more than five votes. It is equally impossible for him to press twice on the same button. To do that he must descend and get up again after the lapse of a few seconds. The rostrum, however, is to be made very large, and the presiding officer will see the elector the moment he gets up and also when he descends. No fraud is possible in this direction. We have omitted to say that the machine is naturally protected by a partition. The apparatus permits of the lists being supplied in different colours. There is a button on which the elector must press to obtain a white paper. This button produces the same ringing as the others. Secret voting is thus absolutely ensured; moreover, a number of electricians and sceptics have already been to see the machine, and all, or nearly all, have recognised its practical use. For our part, concludes our contemporary, we have questioned the inventor on a number of points, and all our doubts vanished before the precise answers and conclusive experiments. The tell-tale cupboard will be naturally closed at the commencement of operations. When the election is finished it will be opened, and the presiding officer will have nothing else to do but to take down the figures given by the tell-tales. An election will thus be counted with great rapidity, and with M. Moreau's apparatus elections will be much less fatiguing for those concerned.

The Telephone at the Frankfort Exhibition.—On Sunday last a telephonic installation, connecting the Opera House with the small detached building in the grounds of the Electrical Exhibition, was opened. The engineers who carried out the work, Messrs. Mix and Genest, of Berlin, have provided upon the stage of the Opera House four specially constructed transmitters, two to transmit the vocal, and two the instrumental portion of the performance. Though, from its peculiar staging, the piece performed upon this occasion (Wagner's Tristan and Isolde) forms a very severe test, the listeners at the exhibition were delighted at the clearness and distinctness with which every note and word was reproduced.

The members of the Electrotechnische Gesellschaft paid their second visit to the Electrical Exhibition, inspecting more especially the telephonic and telegraphic sections. The representative of the Mix and Genest Company, Limited, was in attendance, and explained the uses and construction of the apparatus which are exhibited by that firm in the most complete manner. The elegant portable telephone, an exact copy of that supplied for the writing table of the German Emperor, proved a special attraction.

Electricity in Warfare.—Some interesting experiments have been made in the estuary of the Mersey to test the efficacy of submarine mines as defences of the approaches to the port of Liverpool. For some days the Mersey Volunteer Division R.E., Major Montgomery commanding, devoted themselves to laying down "mines" in different spots, and on Friday the major, with a large party of officers and others interested, proceeded out in the War Office steamer *Lady Heathfield* to see how these mines could be electrically exploded and note the effects. The company included General the Earl of Stair, Sir James Poole (Hon. Colonel of the Mersey Division), Colonels Gore and Brownlow, and other officers. One mine (an iron box containing 100 lbs. of gun cotton) had been laid at a depth of 15 ft. of water off the rocks known as the "Red Noses," and was electrically connected with Perch Rock Battery, as well as with a buoy 200 yards out in the stream. The steamer struck against this buoy, an electric bell immediately rang in the battery, and the mine was fired. This seemed to be practically instantaneous, and the result was that a rudely-constructed raft placed over the mine was hurled up in fragments to a great height, with a vast volume of water. It was easy to see what would have been the fate of a ship placed in the position of the raft, especially if the iron box had contained a full charge of 500 lbs. of gun cotton. Lesser mines were laid with relatively equal effects. A hundred mines are laid in the Mersey as port defences.

Obituary.—Physical, or, perhaps, more especially electrical, science, has been deprived of one of its most ardent workers by the sudden death at his residence in Copenhagen, on the 9th instant, of Prof. L. V. Lorenz, Ph.D. Dr. Lorenz was born at Elsinore on the 18th of January, 1829, and after having completed his studies in applied science at the University of Copenhagen in 1852, he held for a great number of years the post as Professor of Natural Philosophy in the Royal Danish Military Academy. Lorenz was a great mathematician, and is mostly known in connection with his extensive investigations in optics and electricity. Nearly all his papers are published in "Poggendorff's Annalen" and in the Proceedings of the Royal Danish Society, and his name will always be intimately associated with the determination of the electrical units and of the Siemens mercury unit in the C.G.S. system. In 1882 Prof. Lorenz was a member of the International Committee, who met in Paris to fix the electrical units, on which occasion he represented Denmark. He has written several books in his native tongue on light and heat, and also a complete treatise on physics, which belong to the best of its kind written in Danish. Of inventions bearing his name, the Lorenz and Jürgensen dynamo machine, which in 1881 was awarded a gold medal at the Paris Electrical Exhibition, is the most important one. Lorenz was not an inventor; he loved science for its own sake, and his aim in life was an ideal one, leaving it to practical people to form and to shape his purely theoretical conclusions, so that they could be applied in the service of man.

Electric Traction in Leipzig.—It is very probable that the Leipzig Tramway Company will substitute electric for horse traction.

The Frankfort Exhibition.—In the first of a series of articles, entitled, "Walks through the Electrical Exhibition," the *Frankfurter Zeitung* devotes a whole column to a consideration of the exhibits of the Eastern Telegraph Company, and to a general description of the method adopted in the laying of the cables, &c. This is certainly a great compliment to English telegraph engineers, whose work is rarely mentioned in Continental—and especially in daily—papers.

Water Power of the Rhone.—In the report prepared by M. Turettini, regarding the utilisation of the water power of the Rhone near Geneva, it is stated that of the 4,400 H.P. available, only one-half is used. During 1890 no less than 1,565 motors were supplied with current. The motors ranged from $\frac{1}{3}$ H.P., for operating sewing machines, to those of 625 H.P., for the production of electric light. The original cost of the works was £224,000, and the receipts during 1890 amounted to £84,800.

Woodhouse and Rawson's Catalogue.—This catalogue, which, as in former years, is being compiled by Mr. Rentell, is expected to be ready about the end of July. In the meantime, we have been favoured with proof impressions of sections 1, 2, 3, 4, 5 and 7. These give descriptions, illustrations, and prices of prime motors, machinery, lamps, fittings, and tools of every kind. The complete catalogue is probably the most comprehensive publication of the kind in the world, and is an indispensable book of reference for all engaged in the electrical industry.

The Institution of Civil Engineers.—The following are some of the awards made for communications submitted during the past session: For papers read and discussed at the ordinary meetings:—1. Telford medals and Telford premiums to Llewellyn Birchall Atkinson, A.K.C., and Claude William Atkinson, A.K.C., Assoc. MM. Inst. C.E., for their joint paper on "Electric mining machinery." 2. A Telford medal and a Telford premium to Rookes Evelyn Bell Crompton, M.Inst.C.E., for his paper on "The cost of the generation and distribution of electrical energy." 3. A Telford premium to William Langdon for his paper on "Railway train lighting."

Ship Lighting.—The new steel yacht *Lady Ina*, built by Messrs. Ramage and Ferguson, Leith, for Mr. John Anderson, of Hunter's Quay, went her trial trip on the Firth of Forth last week. The *Lady Ina* is the sixth yacht owned by Mr. Anderson, and in every respect excels her predecessors. Electric lighting has been applied throughout.

The ss. *Mira*, recently launched from the yard of Messrs. A. and J. Inglis, Pointhouse, for the Bergen Steamship Company, went on a trial trip on the Firth of Clyde on Saturday. The *Mira* is intended for the tourist traffic in the western fiords of Norway between Bergen and the North Cape, and has accommodation for 120 first-class passengers. The ship has been handsomely fitted up with all the latest improvements, including about 200 incandescent lamps.

Electrical Trade Section.—A meeting of the committee of the Electrical Trade Section will be held at the offices of the London Chamber of Commerce on Monday the 22nd inst., at 3 p.m., to consider the appended agenda. 1. Minutes. 2. Correspondence: Letter from one of the witnesses who attended at the Board of Trade in the matter of the enquiry into electrical standards. Overhead wires: Letter as to Prof. Mengarini, of Rome, being about to transmit 2,000 H.P. from Tivoli to Rome at a pressure of 5,000 volts along bare wire. 3. To consider the desirability of placing wires underground in future. 4. To consider the attitude of the electrical section towards the proposed Crystal Palace Electrical Exhibition, and also the Taunton and South West of England Electrical Exhibition. 5. Frankfort Exhibition: To consider whether a party from the section should visit the exhibition from, say, the 5th to the 15th of August.

Victoria Torpedo Company.—The shareholders of the company have decided that the concern be wound up.

New Cable Service.—The French Submarine Telegraph Company has opened for service a new cable between Puerto Plata and Martinique.

Telephone Patents.—The second important patent for telephones expires next month, and as the Postmaster-General has not moved in the matter of granting licenses for telephone exchanges, questions will be asked on the subject in the House of Commons.

The Eastern Extension, Australasian and China Telegraph Company, Limited.—It is notified that the coupon on this company's 5 per cent. Australian Government Subsidy Debentures, due on the 1st July proximo, will be paid on and after that date at Messrs. Barclay, Bevan and Co., 54, Lombard Street, E.C. Coupons must be left three clear days for examination.

Mr. Edison's Inventions.—A Dalziel's Agency telegram from Boston says Mr. Edison has been sued for $250,000 by Mr. E. B. Welsh, who alleges that he is entitled to a half interest in all the improvements and inventions made by Mr. Edison for the transmission of messages by electricity.

Electric Light on the Stage.—We understand that the novel use of the electric light in the new ballet at the Alhambra, "Oriella," was devised and carried out by Mr. Charles S. Northcote, representing Messrs. B. Verity and Sons. The leading papers in their notices of the performance speak highly of the remarkably pleasing effects produced.

Conversazione of the Society of Arts.—In response to invitations from the Council of the Society of Arts, there was a large assemblage of ladies and gentlemen on Wednesday evening at a *conversazione* held at the South Kensington Museum. The guests, numbering about 2,000, were received as they arrived by the Attorney-General, Sir Richard Webster, M.P., chairman, and several members of the Council. Music formed a leading feature in the evening's programme.

Silvertown Cables.—A useful treatise on electric light cables has been issued by the Silvertown Company, consisting of general notes on insulated conductors, directions as to the choice and erection of overhead and underground cables, quotations from English authorities on high tension underground circuits, testimonials in favour of the Silvertown cables, directions for the electrical testing of electric light mains, and tables of standard sizes of conductors and cables.

Mammoth Electrical Works.—The Detroit Electrical Works have purchased 16 acres of land on which they intend erecting one of the most extensive electrical manufacturing establishments in America. It is expected to have all finished by the 1st of January next year. It is the intention of the company to turn out per day for the first year's work at least five complete electrical equipments for cars, together with one complete generator of a capacity of not less than 100 horse-power. Mr. Louis Warfield, from the Pennsylvania Railroad Company, is now the general manager and treasurer to the company.

An Excellent Arrangement.—In view of the probability of the street pavements being broken up for electric light and other purposes, the Peterborough authorities have adopted an excellent method of laying the asphalt of which the pavements are formed. The material is laid from the house frontages to within a distance of about 18 inches from the kerb-stone, wooden laths being used to ensure the edge of the asphalt setting to a sharp outline. A slip of brown paper is then laid against the edging and the space between it and the kerb filled in with the asphalt, thus completing the pavement. If at any time the latter has to be opened up for the purpose of laying pipes or wires, the 18-inch width can be broken without disturbing the remainder of the surface and leaving a jagged edge, as is usually the case in operations of this kind.

Fire at Newcastle.—Messrs. Barnett, Wynne and Barnard's drawing office and electrical testing rooms at Newcastle-on-Tyne were destroyed by fire on Saturday last, causing considerable temporary inconvenience.

Hotel Lighting.—The Palace Hotel, Aberdeen, which recently passed into the immediate control of the Great North of Scotland Railway Company, is undergoing extensive alterations, and is to be lighted throughout by electricity.

Secondary Batteries.—The Royal Society papers, of which we publish abstracts on pp. 795 and 796, will be interesting to those who manufacture or employ secondary batteries. The experimental researches of Messrs. Ayrton, Lamb, Smith and Woods appear to be in close agreement with those calculated by Prof. Armstrong and Mr. Robertson.

Electricity in Mining Operations.—It would appear from the letters of Messrs. Steavenson and Massey that the United States is not even on a level with this effete old country in the practical applications of electricity to mining operations. Can it therefore be possible that the frequent illustrated descriptions of electrical mining plant which one sees in American exchanges exist only on paper?

Portraiture.—The electrical profession seems to be coming in for a full share of attention from artists. The latest portrait is a very good one of Major Flood Page, the secretary of the Edison and Swan United Company. It is from the hand of Mr. G. B. Black, of 21, Baker Street, and is very well reproduced by lithography. The likeness is not only excellent as regards its fidelity of resemblance, but is at the same time very pleasing in vivacity of expression.

The Royal Society.—The following papers were down for reading last night:—Dr. J. Hopkinson, F.R.S.: "Note on the Density of Alloys of Nickel and Iron;" Oliver Heaviside, F.R.S.: "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field"; Prof. W. G. Adams, F.R.S.: "Comparison of Simultaneous Magnetic Disturbances at several Observatories, and Determination of the Values of the Gaussian Functions for those Observatories."

Solicitors' Charges.—In view of future litigation amongst electrical companies, and the air seems thick with pending lawsuits, we would recommend those who are preparing for battle to peruse the case "In *re* Morse—*ex parte* Latimer Clark & Co.," which we publish in another column. By bringing this matter before the notice of their respective solicitors, each side might derive some pecuniary benefit in the way of reduced charges. The opinions expressed on this case by Lords Justices Lopes and Kay ought also to have a salutary influence upon the legal fraternity. Messrs. Latimer Clark & Co. deserve the thanks of the electrical profession for challenging the charges made against them.

The Electric Light in London.—At their sitting on Monday the Examiners on Standing Orders reported that compliance had been proved in the case of the Bill confirming provisional orders granted by the Board of Trade for lighting certain areas of the metropolis by means of electricity. Two of the orders were granted to the Camberwell and Islington Electric Light and Power Supply, Limited, enabling them to light Camberwell and Islington, and requiring mains to be laid within two years in the following streets, among others: Camberwell Road, Peckham Rye, East Dulwich Road, Lordship Lane, City Road, Holloway Road, Seven Sisters Road and Essex Road. The Brush Electrical Engineering Company, Limited, by the third order in the Bill, are enabled to light St. Saviour's, Southwark, and must, within two years after the commencement of the order, lay down mains in so much of Blackfriars Road, Southwark Street, and Holland Street as lies within the district. The next order enables the Stamford Hill, Tottenham, and Edmonton Electric Light and Power Supply, Limited, to light portions of Putney and Wandsworth, the mains having to be laid within two years in Putney Hill, Putney Bridge Road, Upper Richmond Road, and other streets. The Westminster Electric Lighting order enables the Westminster Electric Supply Corporation, Limited, to light portions of Westminster, and requires the distributing mains to be laid down within two years in Great George Street, Parliament Street, Whitehall, Queen Anne's Gate, King Street, &c.

Rapid Transit in New York.—The commission on rapid transit system in New York gave its report on May 27th. In dealing with improved railway facilities, it was resolved that the motive power for the new lines shall be electricity, or some other power not requiring combustion within the tunnel.

The Weymersch Battery.—The Weymersch Electric Battery Syndicate, Limited, has taken works at Colwell Road, East Dulwich, to manufacture the batteries and carry out any orders with which it may be entrusted. It may have been thought that the Weymersch business had been allowed to slumber, but the directors have refrained from bringing it prominently before the public until it had repeatedly stood the test of practical work. They now feel confident in recommending the Weymersch primary battery as a most convenient and reliable means of producing electric energy. Our own opinion on the battery is well known, and every further information may be obtained at the offices of the syndicate, 2, Victoria Mansions, Victoria Street, S.W.

The Royal Society Soirée.—On Wednesday evening last a distinguished party of ladies and gentlemen were entertained at the rooms of the Royal Society. The guests were received by the President, Sir William Thomson, and the Council. For the amusement of the company, the members of the Royal Society had provided an interesting series of exhibits, of which an instrument by Prof. Carus Wilson, for examining strains in bent glass beams, was, perhaps, intrinsically the most valuable there. The results obtained by this instrument appear to demonstrate that the present theory of strains in beams under flexure is not entirely correct. The most popular exhibit of the evening was furnished by the National Company, who maintained telephonic communication between Burlington House and Liverpool and Birmingham. Among the miscellaneous objects on view was a drawing, the first received in Europe, of a new form of marsupial of mole-like habits and structure —a singular looking little beast.

NEW COMPANIES REGISTERED.

Electrolytic Caustic Soda and Chlorine Trust, Limited.—Capital, £10,000 in £10 shares. Objects: to enter into an agreement to be made between J. C. Richardson of the first part, T. J. Holland of the second part, and the company of the third part, for the sale to the company of the British patents, 1890, No. 2,296, and 1890, No. 2,297, for "improvements in the electrolytic production of caustic soda, caustic potash, and other products from their salts," and for "improvements in apparatus to be used for electrolytic purposes," and to develop, improve, and bring into public use the said inventions. Signatories: T. M. Dunstan, 202, Upper Thames Street, E.C. (25 shares); R. Wakefield, 202, Upper Thames Street, E.C. (10 shares); W. S. Wakefield, 202, Upper Thames Street, E.C. (5 shares); R. C. Baxter, Hethersett, Reigate (50 shares); R. Vogan, 220, Cromwell Road, S.W. (50 shares); T. G. Taylor, 83, Queen Victoria Street, E.C. (5 shares); C. E. Green, United University Club, S.W. (50 shares). The number of directors is not to be less than three nor more than seven, the first being G. R. Tyler, C. E. Green, R. C. Baxter, R. Vogan, Colonel T. J. Holland, and J. C. Richardson. Qualification: £500. Remuneration is to be determined at the general meeting. Registered on the 15th inst. by W. Webb & Co., 23, Queen Victoria Street, E.C.

Ogmore Valley Electric Light and Power Supply Company, Limited.—Capital, £10,000 in £5 shares. Objects: to acquire lands, tenements, plant, machinery, &c., to carry on in the Ogmore Valley and elsewhere in Glamorgan the business of an electric light company in all its branches, and to manufacture, sell and deal in dynamos, lamps, wire cables insulating materials, accumulators, telephones, &c. Signatories (with one share each) J. Williams, Tynewydd, Ogmore Valley; D. S. Rees, Nantymoel; D. Wyndham, Tynewydd; W. Llewellyn, Tynewydd; D. J. Thomas, M.R.C.S., Nantymoel; D. Evans, Nantymoel; G. Williams, Nantymoel; R. A. Williams, Tynewydd; D. H. Evans, Tynewydd; D. Price, Nantymoel. Registered on the 10th inst. by Jordan and Sons, 120, Chancery Lane, W.C. Office, 2, Wyndham Villas, Nantymoel near Bridgends, Glamorgan.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Kensington and Knightsbridge Electric Lighting Company, Limited.—A statement of an increase in the registered capital of this company (£300,000 in £5 shares) of £50,000 in £5 shares, was filed on the 20th ult. The annual return of this company, made up to the 18th ult., was filed on the 23rd ult. The nominal capital is £300,000 divided into 50,000 ordinary, and 10,000 first preference shares of £5 each. 15,000 ordinary and 9,590 first preference shares have been taken up, and upon each of these the full amount has been called. The calls paid amount to £107,550, considered as paid to £15,000, and unpaid to £400. Office, 148, Brompton Road, S.W.

Kensington Court Electric Lighting Company, Limited—The annual return of this company, made up to the 18th ult., was filed on the 23rd ult. The nominal capital is £10,000 in £5 shares. 2,000 shares have been taken up, upon all of which the full amount has been called and paid. Office, 148, Brompton Road, S.W.

Bedford Electric Light Company, Limited.—The annual return of this company, made up to the 16th ult., was filed on the 25th ult. The nominal capital is £15,000 divided into 14,750 ordinary and 250 founders' shares of £1 each. 882 ordinary and 154 founders' shares have been taken up, and upon the founders' shares the full amount has been called, while upon the ordinary shares 1s. per share has been called. The calls paid amount to £197 19s., and unpaid to 3s. Office, 3, St. Paul's Square, Bedford.

LEGAL.

In re Morse—ex parte Latimer Clark and Company.

Court of Appeal. (Before Lord Justice Lopes and Lord Justice Kay.) —This was an appeal from the decision of the Lord Chief Justice and Mr. Justice Day on a question of the taxation of costs. An arbitration of a highly technical character took place under an agreement to refer between two limited companies, the St. James and Pall Mall Electric Lighting Company and Messrs. Latimer Clark and Co., who were their contractors. Mr. Moulton, Q.C., was appointed arbitrator, and the arbitration, which was conducted by a solicitor on either side, lasted 17 days. It was agreed between the parties that a shorthand writer should be employed to take down the evidence, and that three copies of each day's proceedings should be furnished, one for the use of the arbitrator and one for the use of each party. The costs of the reference, including the costs of the shorthand notes, were left to the discretion of the arbitrator to be dealt with by him in his award. Mr. Morse, who was acting in the reference on behalf of the St. James and Pall Mall Electric Lighting Company, agreed to engage the shorthand writer and to pay him, and to furnish the copies to the arbitrator and the other side. He accordingly obtained and paid for a transcript from the shorthand writer of each day's proceedings, and made three copies by means of a type-writer, one of which he kept himself, and gave the others to the arbitrator and his opponent. The question now arose as to the taxation of these items. Messrs. Latimer Clark & Co. objected that Mr. Morse ought not to have made a copy of the notes for himself, but should have used the transcript furnished to him by the shorthand writer, and, further, they contended that the copies, having been made simultaneously by means of a carbon type-writer, ought not to be charged for at the rate of 4d. per folio as if they had been separately copied by hand. The Master overruled the objections, and his decision was upheld by Mr. Justice Wright at Chambers, but the Divisional Court sustained the objections, and from their decision the present appeal was brought.

Mr. W. S. ROBSON argued for the appellant.

Mr. MORTON SMITH was not called upon to support the judgment of the Divisional Court.

The COURT dismissed the appeal.

Lord Justice LOPES said that he entirely agreed with the views taken in the Court below. These type-written copies were made simultaneously by one stroke of the instrument, and it was impossible that they should be charged for at the same rate as if they had been separately and laboriously copied by hand. He could not but feel astonished that the charge had been made. As to the third copy, he certainly thought that the transcript ought to have been sufficient, and that Mr. Morse was not entitled to a copy for his own use.

Lord Justice KAY agreed, and could not but regret to see an attempt to charge in this way. He would have thought that solicitors would be reluctant to make such charges, and it was not fair for a solicitor to deal with his client in this way.

Beard v. National Telephone Company.—(Before Mr. Justice Hawkins and a Special Jury).—This was an action under Lord Campbell's Act, the plaintiff being Mrs. Emma Beard, who sued on behalf of herself and her child for damages for the loss of her husband, William Beard, who was killed by the fall of a telephone pole on land that belonged to the Great Eastern Railway Company, at Bishopsgate Street Station, while the defendants were executing some works there. Substantially, the defence was that the plaintiff's husband was a trespasser, and therefore the plaintiff was not entitled to recover.

Mr. Candy, Q.C., and Mr. Scarlett appeared for the plaintiff; and Mr. Willis, Q.C., and Mr. M. Daniel for the defendants.

The jury returned a verdict for the defendants. Judgment accordingly.

CITY NOTES.

The House-to-House Electric Light Supply Company, Limited.

THE following is the report of the directors to be submitted at to-day's meeting.

The directors have pleasure in submitting to the shareholders (in the form now prescribed by the Board of Trade) balance sheet and profit and loss account, showing the operations of the company from 1st January to 31st December, 1890.

After placing to capital account the debenture interest and loss on working to September 30th, 1890, up to which date the business was being established, the net revenue account shows a credit balance of £385 15s. 8d., which is carried forward to the next accounts.

The period under review has been mainly spent in building up the company's business; the number of lights attached to the company's circuit on the 1st January being 4,520, and the number on 31st December being 13,665, pointing to the probability of good returns in future years.

In this connection the following statement is interesting:—

Date.	Working Expenses.	Revenue.
January to June, 1890	£1,921 0s. 7d.	£1,373 6s. 7d.
July to December, 1890	£2,703 5 10	£3,637 2 7

At the beginning of the year there were 78 houses connected to the company's circuits, and on December 31st there were 248 houses.

The number of connected lamps, as already stated, on December 31st was 13,665, which has since been increased to 16,144 in 304 houses, whilst fully 4,000 more lights are wired, or are in process of wiring.

The company's mains, extending to nearly nine miles, are now laid in the following roads, &c.:—Allan Terrace, Ashburn Place, Astwood Road, Barkston Gardens, Barkston Mansions, Bath Place, Bina Gardens, The Boltons, Bolton Gardens West, Bramham Gardens, Bramham Mansions, Clareville Grove, Claro Terrace, Colherne Mansions, Colherne Road, Colherne Terrace, Collingham Gardens, Collingham Place, Collingham Road, Courtfield Gardens, Courtfield Road, Cranley Gardens, Cranley Place, Cromwell Mansions, Cromwell Road, Drayton Gardens, Earl's Court Road, Earl's Court Square, Evelyn Gardens, Fopstone Road, Foulis Terrace, Fulham Road, Gilston Road, Gledhow Gardens, Gledhow Terrace, Gloucester Mansions, Gloucester Road, Gloucester Terrace, Harcourt Terrace, Harrington Gardens, Harrington Road, Hereford Square, Hogarth Road, Kempsford Gardens, Kensington Road, Kensington Mansions, Knaresborough Place, Lexham Gardens, Marloes Road, Moreton Gardens, Nevern Mansions, Nevern Road, Nevern Square, Newland Place, Newland Terrace, Old Brompton Road, Onslow Gardens, Onslow Square, Pembroke Gardens, Philbeach Gardens, Priory Gardens, Queen's Gate, Redcliffe Gardens, Redcliffe Square, Richmond Road, Roland Houses, Roland Gardens, Rosary Gardens, Somerset Terrace, Stanhope Gardens, Sumner Place, Sussex Place, Trebovir Road, Tregunter Road, Warwick Road, Wetherby Gardens, Wetherby Road, York Mansions.

With a view of providing capital for the extension of the company's business in Kensington, and in order to keep pace with the demand for the light, an issue of 7 per cent. cumulative preference shares was sanctioned in December last by the shareholders. The depressed state of the money market having interfered with the subscription of capital, the directors will be glad if the shareholders will personally interest themselves in this issue, and subscribe the necessary amount to admit of the extension of the Kensington Station, a step which is necessary in order to comply with the obligations of the company's provisional order, and to secure a satisfactory return upon the capital already invested.

The directors are considering proposals for vesting the company's interests outside the metropolitan area in a construction company, and it is hoped that a steady annual addition to the profits of the company will accrue from this source.

During the year Mr. F. J. Burt and Mr. C. T. D. Crews resigned their seats at the board, and the vacancies were filled up by the election of Mr. W. Page and Mr. R. A. Germaine, who are the retiring directors, and, being eligible, offer themselves for re-election.

At the meeting the shareholders will have to elect auditors for the ensuing year; Messrs. Theobald Bros. and Miall being eligible offer themselves for re-election.

Abstract of Accounts to 31st December, 1890.

Capital Account.

Dr.	£	s.	d.
To Expenditure to December 31st, 1890	51,089	14	0
„ Balance of capital account	6,545	6	0
	£57,635	0	0

Cr.	£	s.	d.
By Ordinary shares	26,610	0	0
„ Founders' shares	500	0	0
„ Debentures	30,000	0	0
„ Amounts received with applications for preference shares	525	0	0
	£57,635	0	0

Revenue Account.

Dr.	£	s.	d.
To Generation of electricity	3,965	3	7
„ Distribution of electricity	6	2	10
„ Rents, rates and taxes	198	3	10
„ Management expenses	358	9	8
„ Law and Parliamentary charges	67	4	0
„ Special charges	29	2	6
„ Balance carried to net revenue account	386	2	9
	£5,010	9	2

Cr.	£	s.	d.
By sale of current per meter	4,660	9	7
„ „ „ under contract	30	14	5
„ Rental of meters, converters, &c.	266	5	2
„ Transfer fees	1	2	6
„ Other items	51	17	6
	£5,010	9	2

Net Revenue Account.

Dr.	£	s.	d.
To Balance from last account	23	9	3
„ Interest on debentures paid and accrued to date ...	1,661	16	6
„ Subn. Electrical Association	25	0	0
„ Balance carried forward	385	15	8
	£2,096	1	5

Cr.	£	s.	d.
By Balance from revenue account	386	2	9
„ Foundation of business, including loss on electricity account to 30th September, 1890, and debenture interest to that date	1,709	18	8
	£2,096	1	5

General Balance Sheet.

Dr.	£	s.	d.
To Capital account	42,635	0	0
„ 300 debentures at £100 each	30,000	0	0
„ Sundry creditors on open accounts	7,797	13	10
„ Net revenue account, balance at credit thereof ...	385	15	8
	£80,818	9	6

Cr.	£	s.	d.
By Capital account	51,089	14	0
„ Cash at bankers ... ... „ Cash in hand	922	5	9
„ Sundry debtors for current	2,918	16	8
„ Other „	3,386	1	0
„ Stores on hand...	3,292	19	3
„ Preliminary expenses	3,759	5	11
„ Debenture issue expenses	153	13	2
„ Preference share issue expenses	65	4	4
„ Sundry debtors on account of contracts in course of completion	359	10	10
„ Insurance premium (prepaid)	39	0	6
	£80,818	9	6

City and South London Railway Company, Limited.

AN extraordinary general meeting was held on Thursday last at Winchester House, the object being to pass resolutions for the purpose of raising more capital.

The SECRETARY read the following notice:—

"It is necessary for the efficient working and full development of the traffic on the railway, that the construction of the sidings at Stockwell, approved of at the last half-yearly meeting, should be at once proceeded with. Additional engine power and rolling stock have also been ordered, as mentioned in the last report.

"To meet these and all existing capital liabilities, it is proposed to create, as the most economical arrangement (and in accordance with the usual practice of other railway companies), £150,000 of the share capital as preference stock bearing 5 per cent. interest. Such stock will be offered to the shareholders in the first instance, but only so much of it will at present be issued (about £50,000) as is necessary for the requirements of the company.

"To sanction this arrangement, a meeting of shareholders is called for Tuesday, the 16th inst., when the directors hope you will be able to be present."

The Chairman said the question had arisen before them as to the most economical mode of raising some additional capital for the enlargement, or the making of sidings at Stockwell, which was approved generally at the last half-yearly meeting; also there were certain liabilities in connection with additional rolling stock which would in due course become due; they wished therefore to provide beforehand a sufficient fund for those various amounts. The total estimated amount was probably not more than was said in the circular, about £50,000, The only point they had to consider in the matter was what was the most economical way of raising the additional capital which is required for these purposes. He had said on several occasions, and he still held very much the same view, that it would be very desirable indeed if they could carry this undertaking out without preference capital whatever. If it were done they would occupy an exceptional position, as there was no railway company which had not got preference capital. But it was a new undertaking, and he would like to have done without preference stock. The only point that had arisen was whether the carrying that out would be the best arrangement. Owing to the financial conditions of the London money market, their shares, along with a great many other shares had gone down very much in value, and to issue the ordinary shares at the present price would be establishing a large and future claim on the company by having issued shares very much below what their real value ought to be, and to avoid that they thought the most economical way at present would be to issue a small amount of preference capital, which could be got out at its full price, and without having any loss upon it. Their notion was not to obtain any more than was absolutely necessary for the requirements of the company, but in order to obtain a quotation on the Stock Exchange and make the stock saleable, it was necessary to make it a part of a larger amount, and it was therefore proposed to make it part of a £150,000. It was not, however, intended at the moment to issue any larger amount than between £50,000 and £60,000. That was the position of matters, and it was for the shareholders to say which of the processes they thought was the most economical. The directors had come to the conclusion—with much regret—that what had been proposed is the best way. They (the directors) gave the best advice obtainable, and communicated it so far to the shareholders in this manner. As regarded the present condition of the company, it was the first opportunity that had occurred in which could be given any authoritative statement. Dealing first with the present capital of the company, the authorised capital was £800,000 in shares, £225,000 in borrowed powers, making £1,025,000 in all. Of that there had been issued £630,000 of share capital and £170,000 of debentures. There was, therefore, remaining £55,000 of debentures and £170,000 of unissued ordinary share capital. A portion of the debentures could not be issued until a further sum of some £70,000 of share capital had been placed, and was not available until this was done; but they had £170,000 of share capital available. The amount required at present was, as before stated, some £30,000. By-and-bye they might want more, and it would go to some £60,000 in course of the next six or nine months, and therefore it was proposed to prepare for the finding of that. Coming to the working of the concern in the first instance, when arrangements were all new the power was new, the whole style of working was new in the concern, exceptional preparations had to be made to avoid any breakdowns or failures. They had a staff wholly untrained, because being an absolutely novel undertaking, there was no possibility of getting trained men for a railway of this kind. It was necessary to get a most experienced foreman to educate the staff to their duties, that education had been going on, and some of the hands were now being dispensed with, as the staff grew more efficient. They were also now in a position which enabled them to do away with their expensive educating staff which was had at first. It was therefore seen now what the normal expenditure would be. It was impossible to tell exactly, for they had not sufficient experience, of wear and tear of the electric engines; but still it was possible to arrive at nearly what it would be. The income for the last half-year was at the rate of £40,000 per annum. That income, they were glad to say, was showing symptoms of increase, and the last few weeks has shown decided improvement, and it is to be hoped that next year that increase will show a very decided increase. But assuming that it was not, and that the average was at the rate of £40,000 per annum, the expenses in working, including every expense, administrative expenses, and every expense of the company would reach as near as possible to a figure of about £28,000 per annum. That will leave a profit of about £12,000 on the present earnings. It was very small at present, but it was sufficient to pay their debenture interest, which was a little over £8,000, and leave a sum of £3,000 or £4,000 as a margin of profit. If, as he hoped, during the next twelve months the receipts were increased £10,000 or £20,000 per annum, they would be in a fair way to pay an early dividend. In the case of an increase of £10,000 they could pay 1½ or 2 per cent., or £20,000 3½ or 4 per cent. That would of course depend upon the receipts for the next twelve months. This was the actual position as near as they could give it. They had hopes that they could diminish the expenditure below the figure he had given. Looking at the short time the company had been open, and comparing it with the early stage of most railways he thought the shareholders would have to go very far before they would get as favourable a statement as the one before them, considering that this was an entirely new department. Under those circumstances the company have reason to congratulate themselves upon their fairly prosperous condition. He could not say that he was satisfied, because he hoped that there would have been a much larger traffic at the beginning, but it was a traffic which showed symptoms of steadily increasing. The company started with an absolutely uniform fare of 2d., but it was found after a time that in certain portions of the day that fare was too high, and did not fill the trains. They were very far from full, so the opportunity was taken of trying a reduction within the last few weeks, and it had been tried successfully, and a very much larger number of passengers were being carried, and the line was very much more popular. They had carried already £3,000,000 of people in perfect safety, and that was something to their credit. They were very anxious to give a rapid train service. Unfortunately, the locomotives had not come up to the power which they had contracted to give them, and they have not therefore been able to get that speed and that number of trains which they expected. They are steadily trying to improve those locomotives, and had ordered some others from a different maker which are guaranteed to give a still greater speed, and as soon as these are received, and the rolling stock and carriages being built, they would be able to increase the train service. The company find that they require some additional siding accommodation, and to get this it was proposed to extend a portion of the Clapham line. In conclusion, the Chairman proposed the following resolution:—

"1. The creation, under the powers of the City and South London Railway Act, 1890, of preference shares or stock to the amount of £150,000.

"2. The cancelling, rescinding, or amending any resolution or resolutions already passed by the company which may conflict or interfere with the powers of the company to create the said shares or stock."

The resolution was seconded by Mr. Hanbury.

Mr. Court then moved, as an amendment, that the meeting be adjourned, in order to give the shareholders an opportunity of considering the matter.

This was agreed to.

Electric and General Investment.

The Duke of Marlborough presided on Wednesday at the second ordinary general meeting of the Electric and General Investment Company, Limited, held at Winchester House, E.C. The report, which was published in our last issue, was taken as read.

In moving the adoption of the report and accounts,

The Chairman said the net profit earned during the year was £2,592, which the directors recommended should be distributed in the form of 10 per cent., together with a bonus of 12s. 6d. per cent., £266 to reserve, and in payment of £1 5s. on each founders' share, and of £59 as additional remuneration to the directors, according to the articles of association. He remarked that during the past year there had been but very little time for business, in the very nature of things, that being the first year of their operations. He thought a great deal of credit was due to the prime movers in the formation of this enterprise, who had foreseen the enormous development of electric lighting.. They saw that the ordinary financial houses were not generally conversant with electric lighting matters and the progress of that industry. The moment had now come when electric progress had reached a commercial basis. People were able now to give very exact prices as to the cost of plant to produce power for a given number of lights, and to calculate with very great certainty the profit to be derived from an undertaking. The gentlemen who formed this company foresaw that there would very probably be large demands made for capital for carrying out the various projects, both for the City of London and the provinces, and during the year's experience the directors had had they saw enormous promise of business. The function of this company was to try and set those enterprises on their legs on a thoroughly conservative and proper basis, not intending to take any undue profits, but simply employing their energies in floating those concerns, and also in selecting those which promised well, and rejecting those in regard to which their experience told them the time had not arrived for pushing. The actual business done this year had not been very large, though, considering the amount of capital subscribed, he thought the shareholders would be satisfied with the results. Although it would be premature to say we had arrived at a time when electricity was going to displace gas, he had no doubt that in a short time it would be a very serious competitor with gas, and probably—especially in the City of London—it would supplant it altogether.

The motion was seconded by Mr. George Herring, and agreed to.

A vote of thanks to the chairman closed the proceedings.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended June 12th amounted to £5,670.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 12th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company were £4,027.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (June 11.)	Closing Quotation. (June 11).	Business done during week ending June 18, 1891.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	46½— 47½	46 — 47	45½	...
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84 — 85	84 — 85	85	84
2,809,310*l*	Do. do. Deferred	Stock	11 — 11½	11 — 11½	...	...
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12¼	11¾— 12¼	...	...
84,500*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
63,416	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅜— 2⅝	2½— 2¾	2⅞	$2\frac{9}{16}$
63,416	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅝— 1⅞	1⅝— 1⅞	$1\frac{11}{16}$	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	4 — 5	4 — 5	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	106 —108	106 —108	107⅜	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	½— ⅝xd	$\frac{7}{16}$— $\frac{9}{16}$	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅜— 10⅝	10⅜— 10⅝	10⅝	10¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14½— 14¾	14½— 14¾	14¾	14½
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	...	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 — 110	107 —110	107½	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	107	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¾—15¼	14¾— 15¼	$15\frac{13}{16}$	$14\frac{15}{16}$
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 —107	104 —107	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5 — 6	3 — 4	$3\frac{7}{16}$	3⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1¾— 2¼	1¾— 2¼	2⅞	2
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3¼— 3¾	3 — 3½	$3\frac{9}{16}$	2⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¼— 1¾	1½— 1¾	1⅜	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— $9\frac{7}{16}$	9½— 9¾	$9\frac{11}{16}$	9½
180,042	Do. do. 6 p. c. Preference	10	$15\frac{3}{16}$— 15⅝	15 — 15¼	15¼	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18½— 19	18¾	$18\frac{11}{16}$
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10 — 11	10 — 11	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19¼	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	40½	40¼
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8¾— 9¼	8¾— 9¼	9⅛	$8\frac{15}{16}$
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝— 4⅞	4¾— 5	5	4½
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 12¾	12¼— 12¾	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	11¾— 12¼	12 — 12½	12¼	12
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —106	104 —106	105¼	104½
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	5 — 6	4½— 5½	5	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	8 — 8½	8 — 8½	...	...
3,381	Submarine Cables Trust	Cert.	114 —118	114 —118	116¾	116¼
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4⅝	...
37,350	Telegraph Construction and Maintenance, Limited	12	46 — 48	46 — 48	47	46
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	103 —106	104¼	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	95 — 98	95 — 98	...	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	100 — 105	100 — 105	...	...
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½	11⅛	...
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6⅝	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4½— 5	4½	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	103 —106	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	3 — 3¼	2¾— 3	$3\frac{1}{16}$	2¾
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½— 12	10¾— 11¼	10¾	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9½— 10½	9½— 10½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —104	100 —104	...	..
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	5	4¾—5¼	4¾— 5¼	$4\frac{15}{16}$	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅝.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 36—37.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid) 4¾—5¼.—Liverpool Electric Supply, £3 paid, 2⅝—2⅞.—London Electric Supply Corporation, Ordinary (£5 paid), 2—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—National Telephone Debentures, 2½—3 prem.—St. James's and Pall Mall Electric Light £5, 5⅞—6⅛.—St. James's and Pall Mall, 7 per cent. pref., ¾—1 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅝.—£5 Preference, fully paid 3⅞—4⅜.—Debentures 90—95.—Wards Electric Car, £10 paid, ¾—1.

BANK RATE OF DISCOUNT.—3 per cent. (18th June, 1891).

COMMUNICATION WITH LIGHTHOUSES.

On Friday last Sir M. Hicks-Beach received at the Board of Trade a deputation from the Associated Chambers of Commerce, which asked that a system of telegraphic or telephonic communication might be established between coastguard and lifeboat stations, lighthouses and lightships, and the general telegraphic system of the country. The President of the Board of Trade was accompanied by Sir Henry Calcraft, K.C.B.; Sir George Nares, Mr. Trevor, C.B.; and Mr. Walter Howell. The members of Parliament present were:—Sir George Elliot, Sir E. J. Reed, Sir Albert Rollit, Colonel Hill, Mr. Roe, Mr. Murdoch, Mr. Lea, Mr. Colman, Mr. Herbert Gladstone, Mr. Isaac Wilson, Mr. Lyell, Mr. Grotrian, Mr. Esslemont, and Dr. Farquharson.

Colonel Hill, M.P., presented a memorial from the Associated Chambers, which set out the need for this communication, instancing the wreck of the *Schiller*, when 331 lives were lost close to the Bishop Lighthouse. The coroner's jury found that had the lighthouse keepers been able to communicate with the shore the whole of these 331 lives would have been saved. It was a matter of national importance that means of communicating with the shore should be provided, and it was estimated that this could be done for £100,000. In time of war, the information that could be given of the movement of ships would be most valuable to the naval and military authorities. Other countries, such as France, Denmark, Norway, Holland, Sweden, Canada, and the Cape, had their lighthouse connected by telegraph and telephone with the general telegraphic system of those countries. We ought not to be behind any other nation in those means of saving life and property. In compliance with the suggestion of Sir Michael Hicks-Beach, they presented a list of the more important places in which communication should be established. They were:—St. Agnes, Scilly, Start, St. Alban's Head, Dungeness, North Foreland, Cape Clear, Flamborough Head, Rattray Point, South Stock, St. Anne's, and Lundy Island.

Sir Albert Rollit, M.P., Mr. Grotrian, M.P., Mr. Bayly (Plymouth), Mr. Pomeroy (Cardiff), Mr. Wigham (Dublin Chamber of Commerce), Mr. Esslemont, M.P., and Mr. Lyell, M.P., also spoke.

Sir Michael Hicks-Beach, in reply, said: I do not understand that you come to me to-day to suggest that this communication should be established for the purpose of trade. All that you ask me to consider is the question so far as it affects the saving of life in cases of wreck. I must ask you, in turn, to understand that I really can have nothing to do departmentally with the matter so far as it affects the coastguard service, which is, of course, under the Admiralty. One of the speakers has already alluded to the experiment which has been made in this matter with regard to the Sunk lightship. I think a cable was established between the Sunk lightship and the mainland something like four years, and the result of that was that a committee reported that, although the experiment had shown that electrical communication could be established even in such positions, yet that the experiment should be discontinued as really having been of no service; that is the position of the case at present. You wish that the experiment should not only be renewed, but that it should be very largely extended. Your request that this should be done, to some extent in certain places, at the cost of the Mercantile Marine Fund would, I think, come to me more strongly if it were backed by those who pay.

Colonel Hill: I think the shipping interest would probably not be averse to making some contribution. But there is a very strong feeling that this is not a matter entirely concerning the shipping interest; that it is of such great national importance, that we might fairly ask the Treasury to undertake it.

Sir M. Hicks-Beach: Then I must ask you to go to the Chancellor of the Exchequer, and persuade him to give you a grant for that purpose. But I am perfectly confident what his answer would be to me if I were to make such a proposal to him. I tell you frankly that I am disposed to pursue the experiments somewhat further. I do not think it is enough to take the Sunk lightship as definitely concluding the matter, and I should be perfectly willing, if the shipping interests were willing, that, at any rate, in some of those places mentioned, or in other places, measures should be taken for establishing electrical communication even at the expense of the Mercantile Marine Fund. I do not think that I can say anything that will show you more than that I am in sympathy with you as far as I can safely go.

PROCEEDINGS OF SOCIETIES.

Royal Society.

A Study of the Planté Lead-Sulphuric Acid-Lead Peroxide Cell, from a Chemical Stand-point. Part I. By G. H. Robertson. Communicated by Professor Armstrong, F.R.S. Received May 27th, 1891.

(*Abstract.*)

The author, in the introduction, states that though, since Frankland in 1883 published his first "Contribution to the Chemistry of Storage Batteries," the capabilities of the Planté cell have been well tested and are now thoroughly understood, there is still considerable uncertainty as to the precise nature of the chemical changes which attend their use; and that it was principally to study the part played by the electrolyte that the investigation, the results of which are recorded in this paper, was instituted about a year ago at the Central Institution at Dr. Armstrong's suggestion, as McLeod's observations on the electrolysis of sulphuric acid solutions led to the supposition that the changes occurring in the acid were probably less simple than was commonly supposed. This supposition was verified.

The first section of the paper deals with the nature of the lead salt formed during discharge. It is pointed out that, as is well known, red lead varies considerably in composition, generally containing a smaller proportion of peroxide than is represented by the formula $Pb_3O_4 = PbO_2 2PbO$; and that with nitric acid it behaves as though it were a mixture of the two oxides, the nitric acid always dissolving out the monoxide. There is no reason why sulphuric acid should not behave similarly, and, since lead sulphate is but very slightly soluble, red lead may be expected always to yield a corresponding sulphate, *i.e.*, a mixture of peroxide and sulphate, containing an amount of sulphate corresponding to the amount of monoxide originally present in combination with the peroxide. At Dr. Armstrong's request a number of experiments were made at the Central Institution (long prior to the reading of Messrs. Gladstone and Hibbert's papers) by two students, Messrs. Briggs and Ingold, on various samples of red lead, with the result that the sulphate formed always corresponded to the monoxide originally present.

As no proof of the existence of a definite homogeneous sulphate corresponding to red lead can be afforded by analysis alone, evidence must be obtained that the product differs in some of its properties from a mixture.

It was to be expected that the E.M.F. of an oxysulphate would differ from that of a corresponding mixture of sulphate and peroxide, and have some definite value; therefore pastes were made of peroxide of lead, peroxide of lead and sulphate in the proportions of 1 to 1 and 1 to 2, and also from the product obtained by treating red lead with dilute sulphuric acid (1 to 5). Experiments made with these pastes showed that there was a difference of degree only between the red lead pastes and the mixtures, and that the lowering of the E.M.F. appeared to depend rather on the intimacy of the mixture, and consequent thorough coating of the peroxide granules with sulphate, than on the proportion of sulphate present.

Mr. Desmond Fitzgerald had already shown, in 1887, at the Institution of Electrical Engineers, that the mere admixture of lead sulphate with peroxide of lead produces a lowering of the E.M.F.

With regard to Frankland's observations respecting the colour of the product formed on the peroxide plate during discharge and the reducibility of the sulphate, the author points out that the colour is due to the incomplete reduction of the peroxide, owing probably to the almost complete blocking up by lead sulphate of the pathways by which the current travels through the electrolyte in the paste; that careful examination of the plugs from a discharged cell shows that the base consists of practically unaltered peroxide of lead, and that the surface, which is rich in $PbSO_4$, is really a mass of partially reduced granules of peroxide of lead which are coated with sulphate.

Also, though pure lead sulphate is very difficult to reduce, it is very well known that mixtures of lead sulphate and peroxide of lead or other conducting substances are reduced with comparative ease, and it is very intimate mixtures of this nature which have to be dealt with as a rule in charging a cell.

In conclusion, the author points out:—

That neither chemical nor electrical tests give any ground for supposing that any other sulphate than the ordinary white $PbSO_4$ is concerned in the interactions occurring in the cell;

That were the sudden lowering of the E.M.F. caused by a change in the nature of the chemical compounds formed on the plates, it is very difficult to account for the very rapid recovery of the E.M.F. exhibited by an apparently discharged cell.

In the second section the electrolyte is dealt with, and after referring to the work of Berthelot, Richarz, Schöne, Traube, and others on the electrolysis of sulphuric acid solutions, the author describes experiments made to test the effect of the addition of sodium sulphate to the electrolyte, as, from information received from Mr. Barber Starkey, it seemed probable that the different behaviour of cells containing sodium sulphate was due to the catalytic action of this salt on the hydrogen dioxide always found in electrolysed acid of the strength used in batteries, and which is probably formed by secondary action from persulphuric acid.

Mr. Preece most kindly aided the investigation by allowing experiments to be carried out at the General Post Office, where one-half of the secondary cells contain 1 per cent. of sodium sulphate and the other half ordinary dilute acid, sp. gr. 1,180. He also put at the disposal of the author the records of the behaviour of the cells, and as they showed that there was much less sulphating with sodium sulphate, as shown by the sp. gr. never falling to the same extent as in the plain cells, but that the general character of the changes in temperature and in sp. gr. during charge and discharge were the same in both types of cell, and of the nature which the work of Prof. Ayrton and others has rendered familiar to all, it was only the distribution of temperature and of sp. gr. which was investigated, and this was found to be very irregular.

It was found that the addition of sodium sulphate, in about the proportion of 1 per cent., to freshly electrolysed acid, or during electrolysis, always produced a diminution in the total quantity of "active oxygen," and brought the amount present in the plain cells down almost exactly to that found in the sodium sulphate cells.

Experiments on the growth of the "peroxides" were carried on during five charges and discharges, but only the figures relating to the first discharge are given, as the other charges and discharges are mere repetitions. The peroxides form at once, then undergo a diminution, and then increase again. The alteration in the totals is due mainly to actions occurring at the lead plate in the plain cell, as at the peroxide plate the amounts steadily increase; in the sodium sulphate electrolyte there is a diminution at both plates, followed by an increase.

Determinations were made of the amounts of "active oxygen" present as persulphuric acid and hydrogen dioxide respectively, and it was established that acid taken from the cell reduced peroxide of lead. The presence of hydrogen dioxide being thus established both directly and indirectly, its effect on the E.M.F. of a cell was tested. It was found that, while its addition to the acid in the case of a lead peroxide couple in dilute sulphuric acid produced an annulment or reversal of the E.M.F., the introduction of hydrogen dioxide into the body of the peroxide paste produced an increase of E.M.F. in the case of a platinum-lead peroxide couple.

The latter experiment was made with a view of reproducing, if possible, the conditions of a cell which is started discharging directly it is fully charged, and in which the persulphuric acid formed at the positive during charge may be supposed to break up with the formation of hydrogen dioxide on the cessation of the charging current, thereby increasing the normal E.M.F. of the cell.

The cause of the pink colour of the acid noticed by Mr. Crompton and others was investigated, and found to be permanganic acid, formed probably from the manganese present in commercial lead.

In conclusion, the author points out:—

That "peroxides" are found in appreciable quantities in the electrolyte during charge and discharge;

That their influence must not be neglected in considering the behaviour of the Planté cell;

And that it is to the electrolyte rather than to the plates that attention must be directed if any considerable improvement is to be effected.

JUNE 11TH.

A STUDY OF THE PLANTÉ LEAD-SULPHURIC ACID-LEAD PEROXIDE CELL, FROM A CHEMICAL STAND-POINT. Part II.—A DISCUSSION OF THE CHEMICAL CHANGES OCCURRING IN THE CELL. By H. E. ARMSTRONG, F.R.S., and G. H. ROBERTSON. Received May, 1891.

(*Abstract.*)

The authors arrive in this paper at the following conclusions:—

1. That the cooling observed in the Planté cell can only be explained as resulting from the dissociation of the dilute sulphuric acid; and as the values given by Messrs. Ayrton, Lamb, Smith and Woods are in practical agreement with those calculated on the assumption that the acid used is sulphuric acid itself, H_2SO_4 that in all probability such acid and not the dilute acid contained in the cell is operative throughout.
2. That the observed loss in efficiency cannot be due to temperature changes, as these arise through actions occurring out of circuit.
3. That it is difficult from a comparison of calculated with observed values of the E.M.F. to arrive at any final conclusion as to the exact nature of the changes which take place in the cell. On the assumption that sulphating occurs at both plates in circuit and under the influence of H_2SO_4, the calculated value is considerably too high; while, if sulphating occur only at the lead plate, the value calculated is far too low.
4. That a counter E.M.F. of about 0·5 volt would account for the observed departure from the highest calculated value. As peroxides are always present in the electrolyte, it is conceivable that such a counter E.M.F. may exist; moreover, there is also the possible influence of the lead support to be considered.
5. That the observed loss of efficiency is to be attributed to the formation of peroxides in the electrolyte, and to the excessive sulphating occurring chiefly at the peroxide plate in the local circuit existing between the support and the paste.

ON ELECTRICAL EVAPORATION. By WILLIAM CROOKES, F.R.S.

It is well known that when a vacuum tube is furnished with internal platinum electrodes, the adjacent glass, especially near the negative pole, speedily becomes blackened, owing to the deposition of metallic platinum. The passage of the induction current greatly stimulates the motion of the residual gaseous molecules; those condensed upon and in the immediate neighbourhood of the negative pole are shot away at an immense speed in almost straight lines, the speed varying with the degree of exhaustion and with the intensity of the induced current. Platinum being used for the negative pole, not only are the gaseous molecules shot away from the electrode, but the passage of the current so affects the normal molecular motions of the metal as to remove some of the molecules from the sphere of attraction of the mass, causing them to fly off with the stream of gaseous molecules proceeding from the negative pole, and to adhere to any object near it. This property was, I believe, first pointed out by Dr. Wright, of Yale College, and some interesting experiments are described by him in *The American Journal of Science and Arts.** The process has been much used for the production of small mirrors for physical apparatus.

This electrical volatilisation or evaporation is very similar to ordinary evaporation by the agency of heat. Cohesion in solids varies according to physical and chemical constitution; thus every kind of solid matter requires to be raised to a certain temperature before the molecules lose their fixity of position, and are rendered liquid, a result which is reached at widely different temperatures. If we consider a liquid at atmospheric pressure—say, for instance, a basin of water in an open room—at molecular distances, the boundary surface between the liquid and the superincumbent gas will not be a plane, but turbulent like a stormy ocean. The molecules at the surface of the liquid dart to and fro, rebound from their neighbours, and fly off in every direction. Their initial velocity may be either accelerated or retarded according to the direction of impact. The result of a collision may drive a molecule in such a direction that it remains part and parcel of the liquid; on the other hand, it may be sent upwards without any diminution of speed, and it will then be carried beyond the range of attraction of neighbouring molecules and fly off into and mingle with the superincumbent gas. If a molecule of the liquid has been driven at an angle with a velocity not sufficient to carry it beyond the range of the molecular attraction of the liquid, it may still escape, since, in its excursion upwards, a gaseous molecule may strike it in the right direction, and its temporary visit may be converted into permanent residence.

The intrinsic velocity of the molecules is intensified by heat and diminished by cold. If, therefore, we raise the temperature of the water without materially increasing that of the surrounding air, the excursions of the molecules of the liquid are rendered longer and the force of impact greater, and thus the escape of molecules into the upper region of gas is increased, and we say that evaporation is augmented.

If the initial velocities of the liquid molecules can be increased by any other means than by raising the temperature, so that their escape into the gas is rendered more rapid, the result may be called "evaporation" just as well as if heat had been applied.

Hitherto I have spoken of a liquid evaporating into a gas; but the same reasoning applies equally to a solid body. But whilst a solid body like platinum requires an intense heat to enable its upper stratum of molecules to pass beyond the sphere of attraction of the neighbouring molecules, experiment shows that a very moderate amount of negative electrification superadds sufficient energy to enable the upper stratum of metallic molecules to fly beyond the attractive power of the rest of the metal.

If a gaseous medium exists above the liquid or solid, it prevents to some degree the molecules from flying off. Thus both ordinary and electrical evaporation are more rapid in a vacuum than at the ordinary atmospheric pressure.

I have recently made some experiments upon the evaporation of different substances under the electric stress.

Evaporation of Water.—A delicate balance was taken, and two very shallow porcelain dishes were filled with acidulated water and balanced on the pans. Dipping into each dish—touching the liquid, but not the dish—was a platinum wire, one connected with the induction coil and the other insulated. The balance was left free to move, but was not swinging, the pointer resting at the centre of the scale. The water in connection with the coil was first made positive. After 1¾ hours there was scarcely any difference between the weight of the insulated water and that which had been exposed to the positive current. Equilibrium being restored, the current was reversed, the negative current being kept on the dish for two hours. At the end of this time the electrified water was decidedly lighter. After having again restored equilibrium, the electrification of the dishes was reversed, *i.e.*, the one that had before been insulated was made negative and the other one was insulated. In an hour the electrified water had become decidedly lighter than the insulated water. The experiment was performed in a room of uniform temperature, and any draught was prevented by the glass case of the balance. In a subsequent experiment in which the quantities were weighed, it was found that negatively electrified water lost in 1½ hours $\frac{1}{1000}$th part of its weight more than did insulated water.

This experiment shows that the disturbing influence which assists evaporation is peculiar to the negative pole even at atmospheric pressures.

The metal cadmium was next experimented upon.

Evaporation of Cadmium.—If the flying-off of the metal of the negative pole is similar to evaporation or volatilisation, the operation should be accelerated by heat.

A tube was made as shown in fig. 1. A and B are the platinum poles sealed through the glass. C and D are two blocks of metallic cadmium of the same size and weight. The piece C is in contact with the pole B, which in the experiment was always kept negative, the pole A being positive. When the exhaustion was such that the passage of the current gave green phosphorescence over the glass, heat was applied simultaneously to both ends of the U-shaped tube by means of a gas burner and air bath, so that one piece of cadmium was at the same temperature as the other. The current was then applied and was kept on for about an hour, and it was remarkable that no metal was deposited in the neighbourhood of the positive pole, the surrounding portion of the tube being quite clean, while the corresponding part of the other limb of the tube, having no electrodes, was thickly coated, the appearance being shown in the drawing.

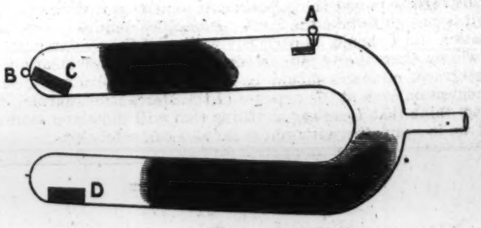

FIG. 1.

As the temperature was high, metal had distilled off from both lumps; hence there was no visible difference in the amount of the deposit in the two sides. It is evident that, to render the electrical action most visible, the temperature should be kept short of the normal volatilising point.

In the next experiment an exactly similar tube was used; the vacuum was such that the green phosphorescence of the glass was well seen, the temperature was kept just below the melting point of cadmium, and the current was kept on for an hour. On examining the tube at the end of this time, the appearance was as seen in fig. 2. A considerable deposit had taken place on the end of the tube near the negative pole, the space round the positive pole was clear, while in the limb of the tube where no electricity had been passing only a very little deposit of metal was seen, as shown in the figure.

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* Third Series, vol. 12, p. 49, January, 1877, and vol. 14, p. 169, September, 1877.

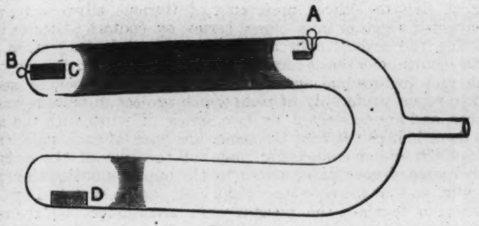


FIG. 2.

The temperature in this experiment having been kept below the melting point, had no electricity been applied, there would have been very little, if any, evaporation. The amplitude of the molecular oscillations was increased by the rise of temperature, but not sufficiently to allow many of the molecules to pass beyond the sphere of attraction of the mass. When, however, the current was turned on, the oscillations were increased sufficiently to carry some of the molecules beyond their spheres of attraction and hence into the vacuous space above. As in the water experiment, this only happens at the negative pole. It would seem that, even after having been *removed* from the rest of the mass, the on-rushing stream of gaseous molecules is necessary to carry the metallic molecules away, and, as I shall presently show, even then they very quickly drop out of the ranks and deposit on the walls of the tube.

Another tube was made as shown in fig. 3. The poles A, B, C, D, were platinum wires sealed through the glass, A and D having aluminium poles covering the platinum wire. In the ends of the tube, and touching the poles B and C, were two pieces of cadmium of the same size and shape. The tube was exhausted to the phosphorescent point, and the current was turned on, C being made negative and D positive. No heat was applied. The current was kept on for about half an hour, until a good deposit of metal had been deposited on the glass, the appearance being as shown in fig. 4, the glass near the pole C being coated with metal, while the glass round the pole D was clean. The outer boundary of the dark space during the experiment is shown by the dotted line *e f.*

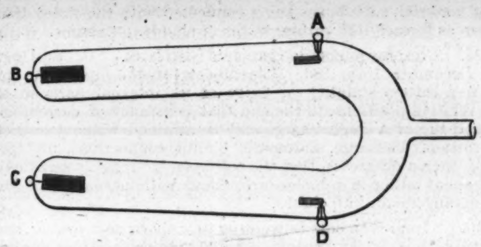
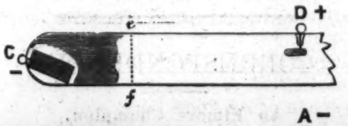


FIG. 3.

FIG. 4.



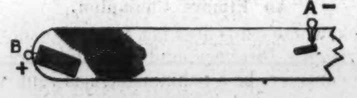


FIG. 5.

The pole B was now made positive and the pole A negative, the current being kept on for another half hour. At the end of the time the only additional effect was a slight darkening round the lump of cadmium, in the same place as, but very much fainter than, the deposit shown in fig. 5. This is probably due to a little leakage of negative discharge from the positive pole. The experiment shows that positive electrification does not cause the metal sensibly to volatilise.

In these experiments no estimation was made of the weight of metal removed, and the cadmium only rested by its own weight upon the platinum wires that had been sealed through the glass. To render the experiment quantitative, and at the same time to remove any disturbing effect that might be caused by heating at the point of indifferent contact, the following experiments were made:—

A U-shaped tube, shown in fig. 6, had a platinum pole sealed in each end. 6 grains of pure cadmium were put into each limb and fused round the platinum wires. The ends of the tube were then put into an air-bath, and kept at a temperature of 200° C. during the continuance of the experiment.* The exhaustion remained at 0·00076 mm., or 1 M. The induction current was kept going for 35 minutes, the pole A being negative and B positive. At the end of this time it was seen that most of the cadmium had disappeared from the negative pole, leaving the platinum wire clean, no metal being deposited near it, and the molecules appearing to have been shot off to a distance of about ¾ inch. The appearance of the positive pole was very different; scarcely any of the cadmium had been volatilised, and the condensed metal came almost close to the pole. The tube was opened, and the remaining wires and metal were weighed. The cadmium was then dissolved off the poles in dilute acid; the residue was washed, dried, and weighed.

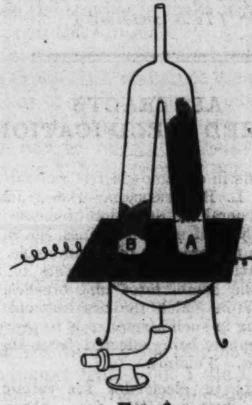


FIG. 6.

		Positive pole.	Negative pole.
Original weight of cadmium	...	6·00 grs.	6·00 grs.
Cadmium remaining on the pole	...	3·65 „	0·25 „
Cadmium volatilised in 35 mins.	...	2·35 „	5·75 „

The difference between the amount of cadmium driven from the two poles having proved to be so decided, another experiment was tried in a tube so arranged that the metal could be more easily weighed before and after the experiment. The apparatus is shown in fig. 7. A tube was blown U-shaped, having a bulb in each limb. The platinum poles were, as before, at the extremities of each limb, and in each bulb was suspended from a small platinum hook a small lump of cadmium, the metal having been cast on to the wire. The wires were each weighed with and without the cadmium. The tube was exhausted, and the lower half of the tube was enclosed in a metal pot containing paraffin wax, the temperature being kept at 230° C. during the continuance of the experiment. A deposit around the negative pole took place almost immediately, and in five minutes the bulb surrounding it was opaque with deposited metal. The positive pole with its surrounding luminosity could be easily seen the whole time. In 30 minutes the experiment was stopped, and after all was cold the tube was opened and the wires weighed again. The results were as follows:—

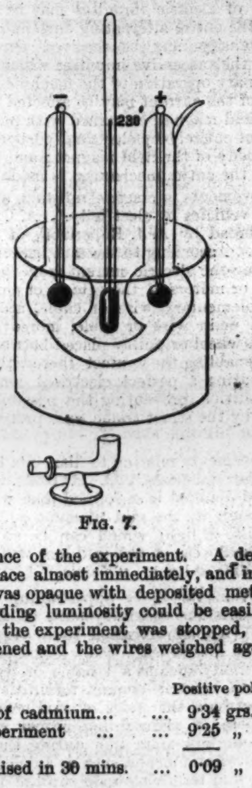


FIG. 7.

		Positive pole.	Negative pole.
Original weight of cadmium...	...	9·34 grs.	9·38 grs.
Weight after experiment ...	...	9·25 „	1·86 „
Cadmium volatilised in 30 mins.	...	0·09 „	7·52 „

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* Cadmium melts at 320° and boils at 860°.

Finding that cadmium volatilised so readily under the action of the induction current, a large quantity, about 350 grs., of the pure metal, was sealed up in a tube arranged as in fig. 8,* and the end of the tube containing the metal was heated to a little above the melting point; the molten metal being made the negative pole, in a few hours the whole quantity had volatilised and condensed in a thick layer on the far end of the tube, near, but not touching, the positive pole.

(To be continued.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

536. "Improvements in dynamo-electric generators and motors." C. W. ATKINSON and L. B. ATKINSON. Dated January 10th. 6d. Has for its object in general the provision of means for enclosing the brushes and commutators of such machines, so as to render them suitable for working in the presence of inflammable or explosive atmospheres, and in particular to improvements in the arrangement and construction of the commutator and brushes, as described in Patent No. 16,623, 1887, in which the brushes and commutator are enclosed within a casing in such a manner as to prevent any ignition of the explosive atmosphere being effected from the interior by the sparking of the brushes. 3 claims.

667. "Improvements in electrodes for voltaic accumulators." W. P. THOMPSON. (A communication from abroad by the Hess Electric Storage Battery Company, of America.) Dated January 13th. 8d. Consists in a covering, strata, or layer of the material known to the trade as glass wool, which is made up of finely divided fibres of glass, or glass in a fibrous state, which is therefore highly porous, said glass wool being placed or spread over the face of the active material, or material to become active, and held thereon by a perforated plate of rubber, or any other material not subject to the action of the electricity or solution, or by an insulating strip or strips of a like material, so that, when joined with other plates, a free space between the plates is provided for the circulation of the hydrogen. 4 claims.

669. "Improvements in electrical cut-outs or safety fuses." J. PULUJ. Dated January 13th. 8d. Consists of a platinum wire introduced into a small glass tube closed at either end, so as to form an absolutely fireproof cut-out for electric conductors which may be used even in the midst of explosive gases without any danger whatever. 6 claims.

965. "Improvements in therapeutic magneto-electric machines." H. H. LEIGH. (Communicated from abroad by J. B. Gardiner, of America.) Dated January 20th. 8d. Consists in mechanism whereby the operation of the pulls and the actuation therefrom of the electro-magnetic devices are rendered continuous and efficient, means whereby the resistance to the pull of the operator may be varied or adjusted at will, to suit different individuals; devices whereby the force of the series of electric impulses may be varied at will, or, if desired, whereby the entire alternating current ranging from zero to the maximum intensity may be received through the operator's person, instead of the successive impulses which are selected and received in the ordinary operation of the machine; means also whereby the general force of the current may be affected by a magnetic short-circuiting of the field magnet, combined with means for shutting off this general current entirely by electrically short-circuiting the current through the body of the field magnet; and, lastly, a general construction whereby the entire mechanism is made efficient. 21 claims.

1,114. "Improvements in electric railways and in apparatus for the propulsion of vehicles by electricity." A. CHURCHWARD. (Communicated from abroad by A. J. Robertson, of New York.) Dated January 21st. 8d. According to the said invention the main wire or cable for conducting the electric current from the generator to supply the electric motor or motors of the vehicle or electric locomotive, and the return or supplementary wire or cable, are arranged upon the ground. The said main wire or cable, moreover, is passed over a flanged or grooved wheel or pulley placed between the wheels of the said vehicle, thus enabling the contact therewith to be formed and preserved, and assuring a perfect electrical connection, keeping the wire in a good condition, preventing the possibility of contact being formed therewith by the street traffic, and protecting it from ice and snow. 4 claims.

4,235. "Improvements relating to filaments for electric lamps for signalling and other purposes." J. P. REES. Dated March 18th. 6d. The improved filament is so formed that, when the electric current is passed through it, the said filament will present the appearance of a spot or disc of light, which can be so placed relatively to the lens that the focal axis of the said lens will extend through the centre of the said disc of light. 2 claims.

4,260. "Improvements in or appertaining to automatic safety appliances or cut-outs for use in systems of electric distribution." W. P. THOMPSON. (A communication from abroad by C. G. Young, of America.) Dated March 18th. 8d. Consists of the combination of a source of electricity such as a dynamo or dynamos; a main line in circuit therewith, electric contact terminals normally in closed circuit with and between the poles of said generator and said main line for the purpose of maintaining proper electrical connection between the dynamo and main line during the proper working of the system, and automatic means, such as an electro-magnet, for electrically separating said terminals upon rupture of the main line, the terminals being of iron in part or in whole, and being normally held closed by the power of the magnet whereby they spring open or fall apart when the main line becomes ruptured. 19 claims.

5,678. "Improvements in electric tension regulators or apparatus for automatically controlling or regulating electric currents." J. KALB. Dated April 15th. 8d. Relates to a resistance frame consisting of coils or helices, preferably of German silver wire, which are connected together in a closed series by contact plates or pieces connecting the several coils at the opposite ends thereof, so as to form the continuous series thereof, the series being finally connected at each end to terminal screws. The said coils or helices are connected to wires, preferably of iron, which project in pairs to varying distances, and are connected by two series of wires with the aforesaid coils or helices between the same, one wire of each pair leading from, say, the upper connecting plate or the like of the coils, and the other wire of each pair leading to the opposite connecting plate, or the like, so that more or less of the coils can be switched in or out to increase or decrease the resistance in accordance with the condition of the current. 3 claims.

6,005. "Electric lamp adjuster." G. H. SAYER. Dated April 21st. 6d. Consists of a spring lever clip of a suitable shape, attached by suitable means to the lamp-holder. 1 claim.

13,799. "Improvements in electrical signalling and in apparatus therefor." H. H. LAKE. (Communicated from abroad by the Electric Secret Service Company, of New York.) Dated September 2nd. 8d. Relates particularly to electrical signalling devices of the type known as individual call apparatus, in which any one of a series of out-lying signal receivers, located on a single or common main line, may be called or signalled to the exclusion of all the others not wanted. 25 claims.

18,266. "Improvements in conduits for electric tramways." H. J. DAVIES and L. B. S. DUTSON. Dated November 13th. 6d. The subway conduit or tube will consist of a channel formed of terra-cotta, earthenware, delph, or other approved non-conducting material, protected on the upper surface by means of steel rails, which are held in position by cast iron yokes, at such intervals as may be necessary, and the yokes are secured to the ordinary tram rails by means of tie bars, so as to keep the gauge of tramway uniform. At necessary intervals are specially constructed boxes or chambers lined with the aforesaid terra-cotta, earthenware, delph, or other approved non-conducting material, such boxes being connected with the street drain or sewer, so as to carry off surface water or sludge. 4 claims.

20,126. "Improvement in galvanic batteries." C. E. DUTTON. Dated December 10th. 8d. The objects of the invention are to secure in a battery stability or fixity of its internal parts in their proper relative positions, to the end that constancy of current and a prolonged run of a single charge may be attained without restriction of the rate of discharge, automatic circuit connections, and portability of such a character, that the cell may be roughly handled and carried about either in vehicles or by hand without danger of breakage or derangement. 16 claims.

20,540. "Improvements in welding or otherwise working metals electrically." W. P. THOMPSON. (A communication from abroad by C. L. Coffin, of America.) Dated December 16th. 6d. Claims:—1. The described method of electrically welding metals, consisting in connecting each article with one pole of a generator of electricity, making contact between the ends to be welded and an electric conductor of equal or less resistance, passing a heating current through said articles and said conductor, and completing the weld by pressure. 2. The described method of working metals electrically, consisting in connecting each article with one pole of a generator of electricity, making contact between the ends to be welded and an electrical conductor of equal or less resistance, passing a heating current through said articles and said conductor.

CORRESPONDENCE.

An Elmore Champion.

A Mr. Peck, whose name does not appear to adorn the pages of the *Electrician's Directory*, and may, therefore, for aught I know to the contrary, be a fishmonger, has sent you copy of a letter (which appeared in your last issue), with which he had honoured the *Engineering and Mining Journal* of New York. This letter professes to be a reply to some comments I thought it my duty to make in the public interest, on the so-called "Elmore process." I notice that you have numbered the paragraphs in Mr. Peck's letter, as also those of your comments thereon. With your permission I will make a few observations on that contribution, although I confess to being somewhat sick of this Elmore theme.

(1, 2.) Mr. Peck refers to a letter from "one Alexander Watt, *re* the Elmore depositing process." Well, I will reply to Mr. Peck, although I consider it somewhat an act of impertinence for a person who acknowledges (paragraph 6) that he does "not profess to know much about the subject" to thrust himself forward as a champion of the "Elmore Companies." Mr. Peck says that my assertion that "the opinion of those who understand the electro-deposition of metals thoroughly, seems to be of an adverse character," is a "deliberate misstatement." Of course it is easy for a person who does "not profess to know much about the subject" to accuse *those who do* of making "deliberate misstatements," especially when the statements happen to be unpalatable. Quite regardless of Mr. Peck, however, I adhere to my statements. Mr. Peck, who does not seem disposed to "hide his light under a bushel"—which would practically extinguish four of his capacity—in paragraph 2, has had the bad taste to drag into this matter the names of several gentlemen, to whom I have never in any way referred in my correspondence on this subject, and he has the audacity to ask whether it does not "appear a piece (the exact dimensions of which he does not give) of great presumption on the part of Mr. Watt to dare to create himself judge of such men." Now Mr. Peck's artful, but far too transparent, attempt to give importance to his otherwise silly and uncalled for effusion by dragging in the names of several professional men, with whose views respecting the Elmore process I have no concern whatever, is, I affirm, an act of gross impertinence. But so far as my *daring* to differ from *anyone*, if such should unfortunately happen to be the case at any time, upon any subject connected with the electro-deposition of metals, I can assure Mr. Peck I shall not require a license from *him*.

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* See continuation next week.—EDS. ELEC. REV.

(3.) Mr. Peck appears to think it remarkable that in writing two separate letters, referring to what I conceive to be inherent defects in the Elmore process, I should have employed two different terms to express my views as to what I believe will be the fate of copper tubes made by this process. Mr. Peck is apparently much exercised in his mind as to the cause of what he is pleased to call my "sudden assumption of modesty" (a quality Mr. Peck, of all persons, should the most appreciate) in using different terms, in different contributions, to express the same meaning. To set his mind at rest upon this point, however, I am quite willing to hold to the *stronger* term, which will, perhaps, more fully explain my views, and about which there will be less "weakness or vacillation" to disturb the equilibrium of what Mr. Peck would doubtless consider his mind.

(4, 5.) We are told that Mr. Wm. Elmore is "the father of the inventors, and the managing director of the company." Here we have indeed two refreshing announcements. Mr. Wm. Elmore the "managing director!" Well, we'll see what comes of it. Mr. Peck, however, should be at his elbow, if, indeed, Mr. W. E. did not stand in a similar *posé*, while Mr. P. (who does "not profess to know much about the subject") concocted the letter now under consideration.

In reference to Mr. W. Elmore's wager (referred to by Mr. Peck), the conductors of this journal deserve my special thanks for their dignified refusal to degrade their highly-esteemed paper by permitting me (had I felt disposed to bring myself down to such a level) to accept that person's turfy proposal. As to Mr. Peck's contemptible remarks respecting my non-acceptance of the low pot-house method of settling a technical controversy, as proposed by Mr. Wm. Elmore, by a wager, these I leave him to enjoy in company with any person who may have helped him to concoct his letter.

(6.) Now we come to a really interesting point, but more especially so since it is supposed to be written by a person who says that he does "not know much about the subject." Mr. Peck says "Mr. Watt then tells us that 'metals deposited by electrolysis do not adhere well, if at all, to their kind.' This is news indeed." What! news to a person who professes to know little or nothing—that is "not much"—of the subject! Remember, it is a nice point, Mr. Peck, and none but persons who know *something* about electro-deposition would be able either to confirm or disprove it. Now, I will be frank with this Mr. Peck, since he has candidly confessed that he does not know much about the subject he has somewhat profusely written upon, and will ask: Did not someone *prompt him* as to the various technical points contained in this and other paragraphs of his letter? I will not burthen your useful columns by going over the ground again, having already expressed views to which I firmly adhere. As to Mr. Peck's notions concerning my judgment in matters connected with electro-deposition, as expressed in the latter part of this paragraph, I must content myself by expressing my regret that a person who knows so little of the subject should have taken so much trouble to put them in print.

In reference to my opinion that metals do not adhere to polished surfaces, Mr. Peck says he will "take a charitable view," and content himself by "assuming that Mr. Watt has never heard of Mr. A. Smee's theory as to the cause of deposited metals not attaching themselves to the underlying metal." Since Mr. Peck knows so little about the subject, as he tells us, it is not at all surprising that he should wonder if, during half a century's experience in electro-deposition, I had ever taken the trouble to make myself acquainted with works written upon the subject.

(7) In this paragraph we have a kind of addendum for a flaring Elmore prospectus, and since it enters into statements we have no means of verifying, and would certainly not take upon the *ipse dixit* of Mr. Peck, I will pass it by, and more especially as it has no reference whatever to the defects in the Elmore process I have pointed out, and can only have been introduced as a kind of puff.

(8) Here, however, we come upon matters which require a little more attention—and they shall have it. "Mr. Watt makes the statement that 'Elmore originally professed to produce his copper tubes from *rough copper or matte*.' If it is suggested that this statement appeared in the prospectus, I again contradict Mr. Watt." In reply to this, I once more state that Mr. Elmore *did* originally profess to produce his tubes from copper matte, but I did not say he had stated so in the prospectus referred to, therefore Mr. Peck's contradiction is an unnecessary impertinence. What I did state, however, I will now give my authority for, but I will not favour Mr. Peck—or those for whom he may be acting as mouthpiece, for aught I know—by discussing the sentences quoted from the prospectus, which may be useful for advertising purposes, but are not arguments. Now, as to Mr. Elmore's original professions concerning the material from which his tubes were to be produced. In 1885 Mr. Elmore was negotiating with some gentlemen for the formation of a company to manufacture copper tubes, which he professed to be able to do at £25 per ton. In the case of Elmore *v.* Pirrie and others, tried before Mr. Justice Kay in November, 1887, in which Mr. Elmore sought to recover £15,000 damages for breach of contract, a letter from Mr. Pirrie to Mr. Barrett (also one of the defendants) was read, from which the following extracts (copied from Mr. Justice Kay's judgment) were taken:—"Elmore and Mr. Cooper have perfectly satisfied me that they can make copper tubes at £25 per ton, as against £59 the present cost." Mr. Pirrie, in his evidence said he asked Mr. Elmore "how can you make copper tubes at less than the cost of copper, taking it at £40 per ton, and you are going to make tubes for £25. He then explained to me that his copper tubes had been made from *rough copper or matte* (the italics are my own) for which he showed me different invoices for making it at £18 to £20 per ton." This, then, is what Mr. Elmore originally professed not only to be able to do, but to have actually done; whereas *now* the copper tubes, we are told, are made from Chili bars, at about £53 per ton. If, as "managing director," he could now carry out his original professions, and employ matte at £18 per ton, what an enormous saving that would effect and how his shares would run up! Perhaps he will try, or, on second consideration, perhaps he would rather not!

9. In this concluding paragraph Mr. Peck—"not knowing much about the subject"—"thinks he has dealt with all the points in Mr. Watt's letter," and suggests, with the excellent good taste which is so ornamental a feature in the lucubration before us, that "before the slightest heed is given to Mr. Watt's remarks, your readers should satisfy themselves as to his capacity to criticise the Elmore process, as to his knowledge of that process, and as to his *bonâ fides*." Now as to these three propositions, I will leave myself in the hands of your readers. As to the advisability of a person professing not to know "much" of the subject, entering into technical discussions with all the assurance of an expert, I must leave your readers to form their own judgment, while at the same time they may possibly come to some conclusion as to *why*, and at whose instigation, Mr. Peck should come forth as champion of the Elmore companies. If my own theory be the correct one, his *bonâ fides* in this controversy will, I fear, be open to very grave suspicion.

In conclusion, I may state, for Mr. Peck's edification, that a copy of this letter will be sent forthwith to the *Engineering and Mining Journal* of New York.

Alexander Watt.

Balham, *June 9th* 1891.

Electricity in Mining Operations.

Having opened the discussion at the recent meeting of The Federated Institute of Mining Engineers, which you subject to a very reasonable amount of criticism, I should like to show yourself and readers that we are not quite the benighted heathen requiring enlightenment which electricians to a large extent assume.

We have in this district shafts 2,000 feet in depth, in which cages with their load weighing 8 tons, run at a speed of 1,300 feet a minute, and we are asked to apply to these an apparatus which depends upon "a few cells, such as Daniells, giving a constant current, and requiring no attention except the adding of a few crystals of Cu, SO_4 at intervals," to prevent the action of grips, which would instantly stop, like a blow against a stone wall, these enormous moving weights.

I say no; your remedy is infinitely more dangerous than the disease. I have for many years used electricity for telegraphy in my house, in the mines for signalling, for firing shots, and for igniting the gas in a petroleum engine, and seldom a week passes, that some of them do not fail—they are put right, and no harm is done. But let the battery for the safety catch fail, and terrible results would follow; no guides in the shaft would stand a blow of 10,000 foot tons, but all would go to the bottom together, and, remember, there might be 12 or 16 men in the cage.

You will see, I think, that "this wrong impression" is not on the part of the mining engineers, but of those who wish to persuade them to apply an agent which their own experience has taught them is not suited to the conditions of the case in question.

And now, having finished that part of the subject, at least to my own satisfaction, may I follow your remarks a little further (I always get the ELECTRICAL REVIEW, for I like to know what you are all doing, and saying about us). We are again compared with the wonderful progress made in America in such matters.

But American engineers still come over here and find much in our mines to learn, and I have not met with any who can meet me and prove that upon a single engineering question he is right and I am wrong, in respect of either safety or economy.

I have this week a letter from America (not yet answered) in which the writer says: "Allow me to express my sense of obligations to you for benefits received." And I have another from the same country, in which so much is asked, that I have never been able to find time to reply to it; so that, you may accept my word for it, we are not quite so lost in the mists of antiquity as electricians appear to have persuaded themselves.

A. L. Steavenson.

Durham, *June 13th*, 1891.

Will you kindly say where I, together with others of your readers who are specially interested in this subject, may find details of the "enormous development" which you allude to in your leading article of the 12th inst.

I was in the United States for several weeks last autumn, and I utterly failed to find, except in one solitary case at a coal mine near Pittsburgh, a single practical application of electricity to any of the numerous purposes you mentioned. There was plenty of *talk* of what might be done in the near future, and I was shown, in various works, a few more or less promising experimental machines; but after discussing the whole question fully with well informed Americans, I came to the conclusion that the applications of electricity to mining work in England and Wales were far more numerous than those on the whole of the American continent put together.

As you allude to compressed air, I may say that I had the advantage of visiting, with some of the leading American engineers, the largest compressed air plants of that country, in iron mines, where everything was done by compressed air; and, although it was thought that the application of electricity in other places might ere long be possible, there was no allusion to the substitution of electricity for air on any such scale as you would seem to indicate in your remarks.

I agree with you that the collection of data would have a good effect in the United Kingdom; and you will be glad to learn that, after hammering away for years, I have at last induced the South Wales Institute of Engineers to appoint a committee to consider the matter.

Wm. H. Massey.

June 16th, 1891.

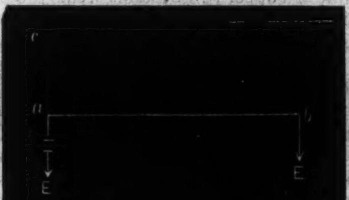
Re "Electrostatic Inductive Capacity."

I am afraid I was rather vague in my statement that the static capacity of a circuit was increased by the addition of a return wire. What I intended to convey was that the static capacity of an *insulated* circuit (without a current flowing through it) was increased by the addition of a return wire; or even the theoretical case of an earth connected return system with a current flowing through it. Viewed in this light I may say it is doubled.

The theory I have put before you is equally applicable to looped *cables* which differ in no essential respect from looped aerial conductors, and without wishing to detract from that theory, which, to my mind, is quite logical and correct, in any way, I think the whole matter may be explained in a few words.

Taking the case of the looped cables. Although as regards static capacity the cables are joined in "cascade" or "series," the sum of the charges (positive and negative) contained on the conductors is equal to the total charge on one of them with earth used, and *not* to half this charge, as per figs. 1 and 2. This rather paradoxical fact is explained by taking a typical case of this kind, as shown in fig. 3. C and C′ are two condensers to represent the capacities of the two cables shunted by equal resistances, R, R′, with the battery between. These condensers are joined in series, and the capacity of the system is half the capacity of a system using only one condenser as in fig. 4. But the sum of the two charges (positive and negative) in the condensers, fig. 3, is equal to the charge in fig. 4, and it is this sum which is represented along the conductors in fig. 2, the charge and discharge being, as I surmise, effected in the manner previously pointed out.

FIG. 1.



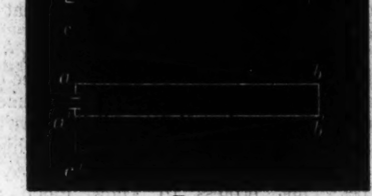
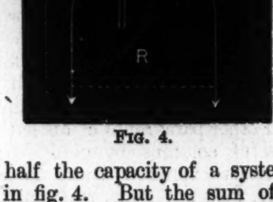


FIG. 2.

FIG. 3.



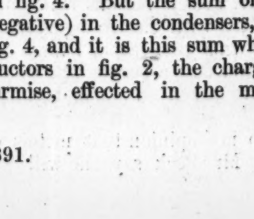
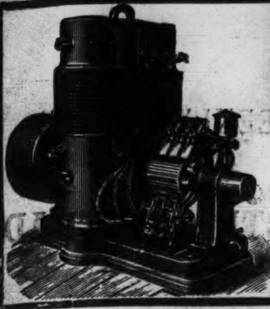


FIG. 4.

J. E. Taylor.

June 15th, 1891.



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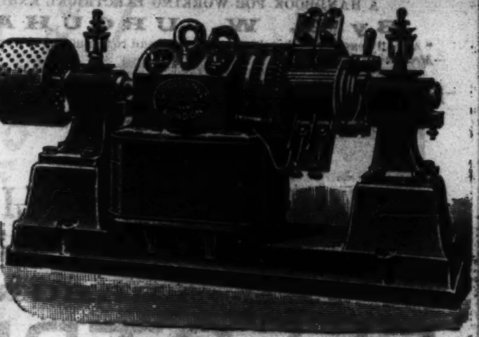

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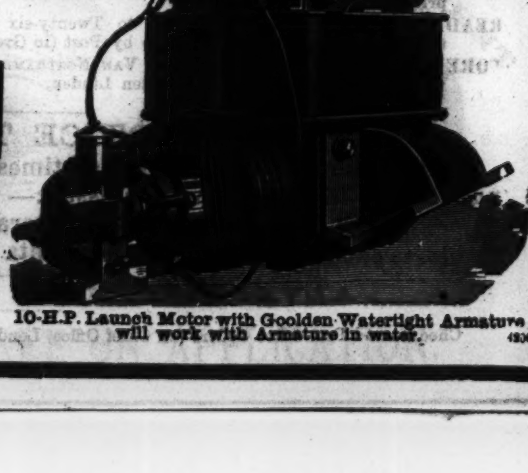

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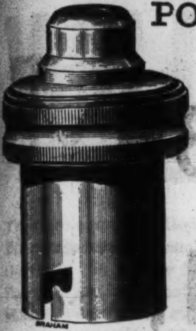

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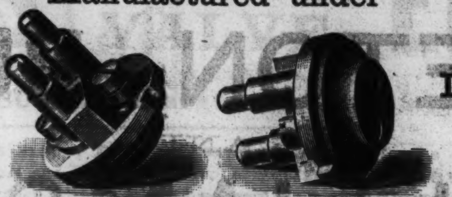

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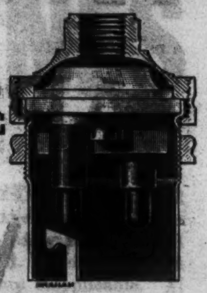

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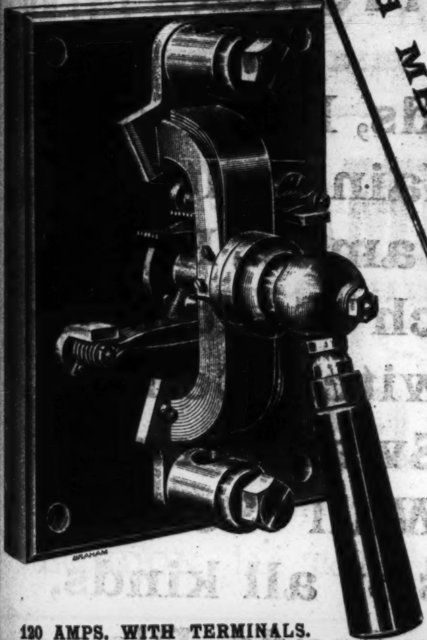
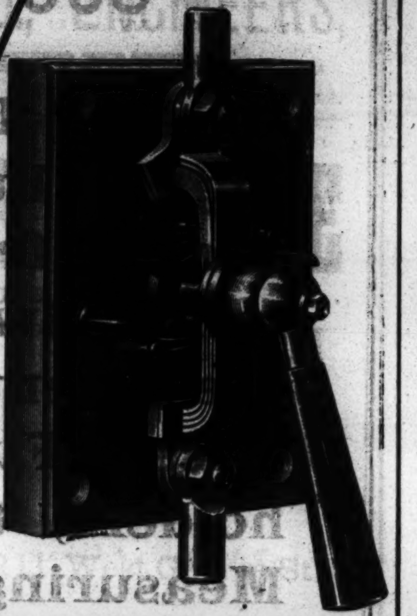


120 AMPS. WITH TERMINALS.

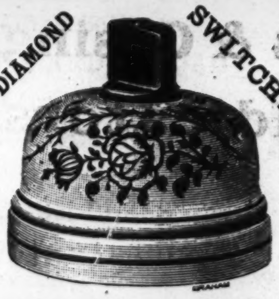
SPECIALITY SWITCHBOARDS

SWITCHES (PATENT)



70 AMPS. WITH CABLE CONNECTORS.

NEW DIAMOND SWITCHES,



PLAIN, OR

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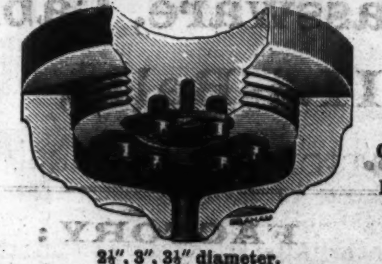
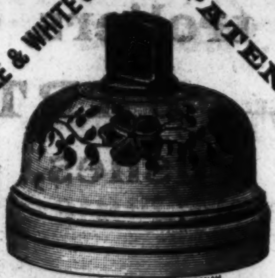


2½", 3", 3½" diameter.

PORCELAIN.

POOLE & WHITE'S PATENT

CREAM, BLACK.



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They are equally suited for **Condensing** or **Non-Condensing**; for the direct driving of **High-Speed Machines,** such as **Dynamos** and **Fans,** or for **Driving General Machinery** by Belts or Gearing. It is now fully established that they possess **Extraordinary Freedom from Wear,** as **all** Bearings are in "constant thrust" (which is not the case with many Single-Acting Engines), and are Self-Lubricated. Their **Small Size and Weight,** while advantageous in all cases, fit them for uses to which the majority of engines are inapplicable. Al except the smallest sizes are made either **Simple, Compound,** or **Triple-Expansion,** according to the pressure available, and recent trials show that they work with a

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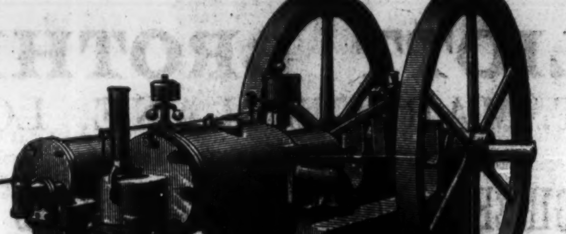

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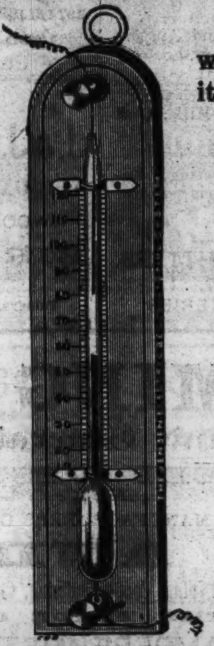

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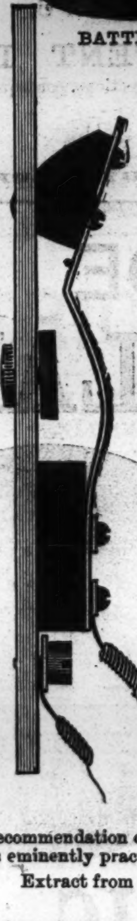
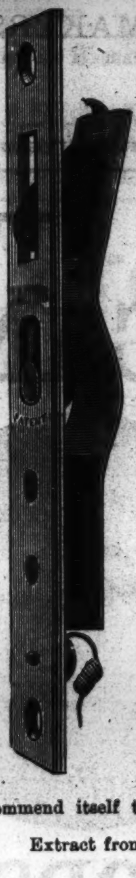


DOOR ALARM



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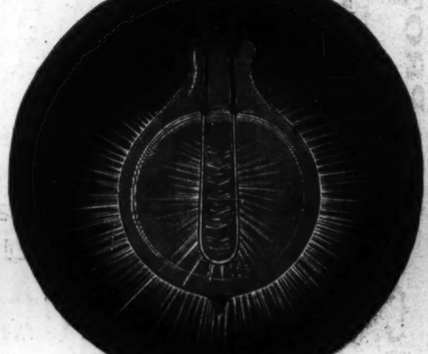

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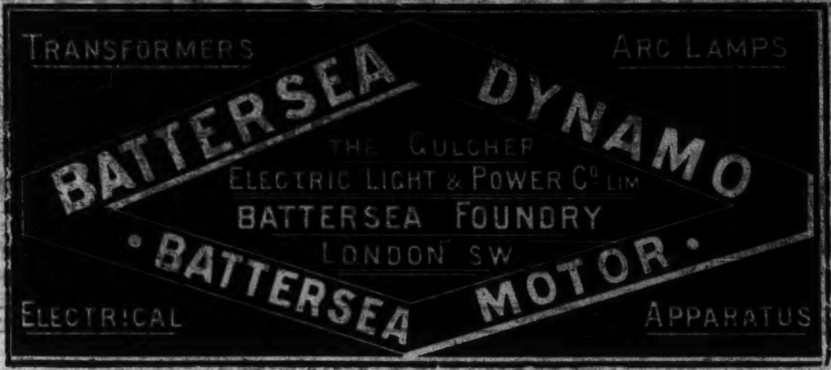

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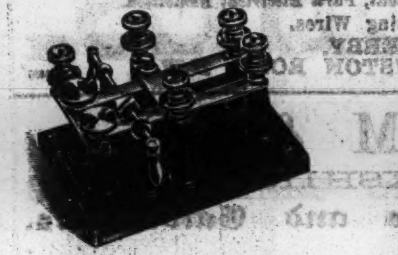

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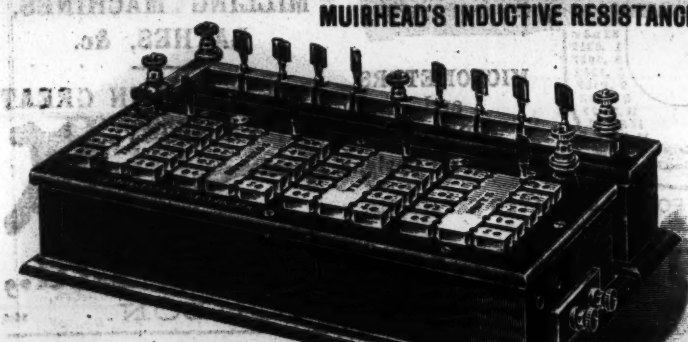

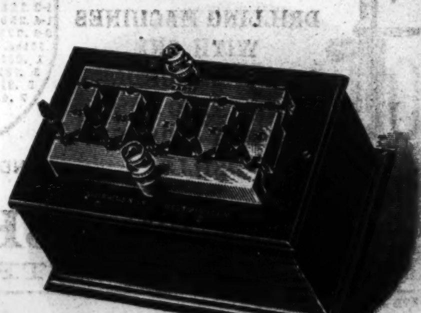

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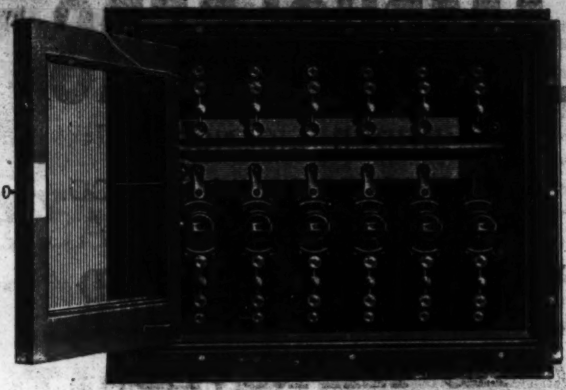

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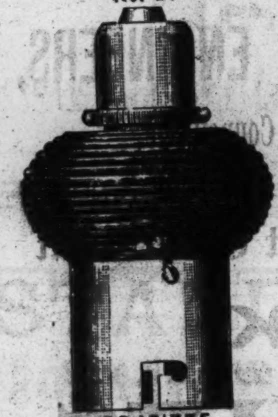

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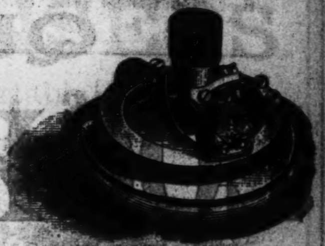

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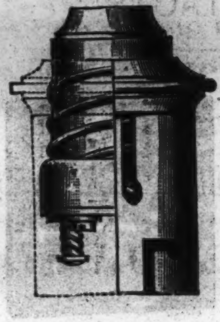

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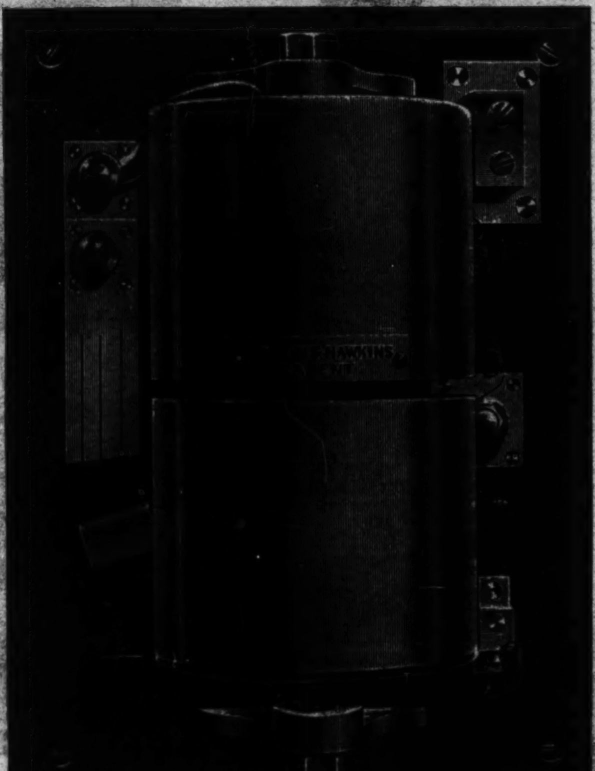

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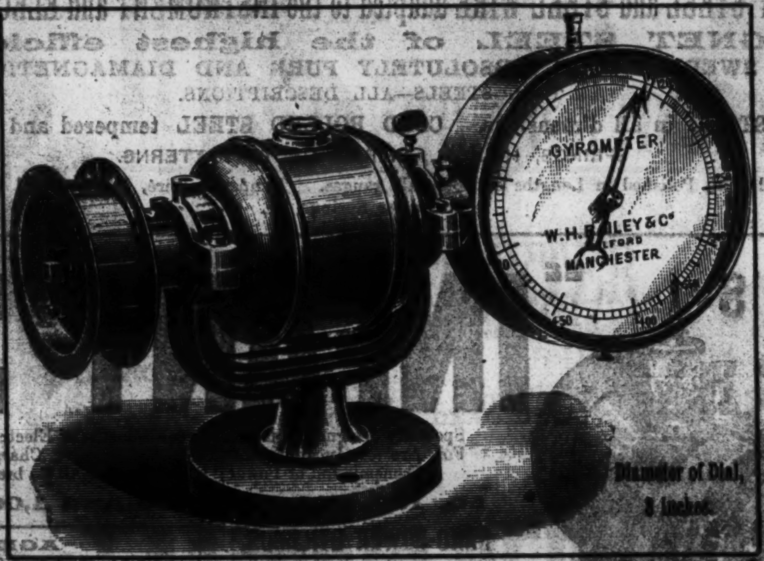

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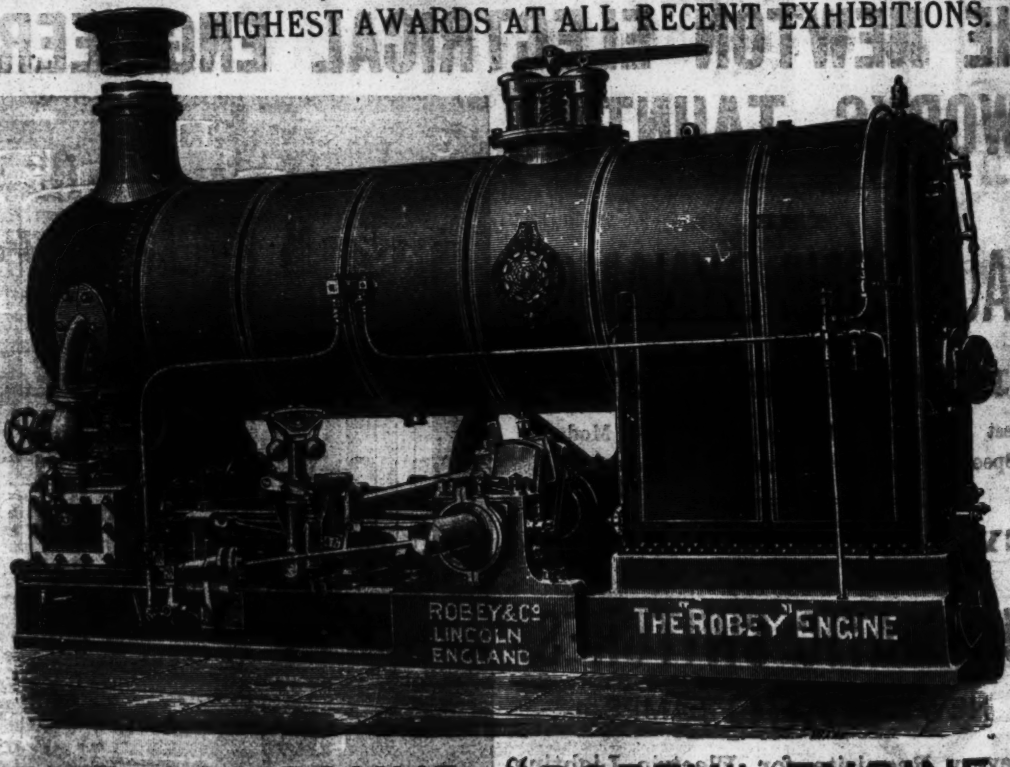

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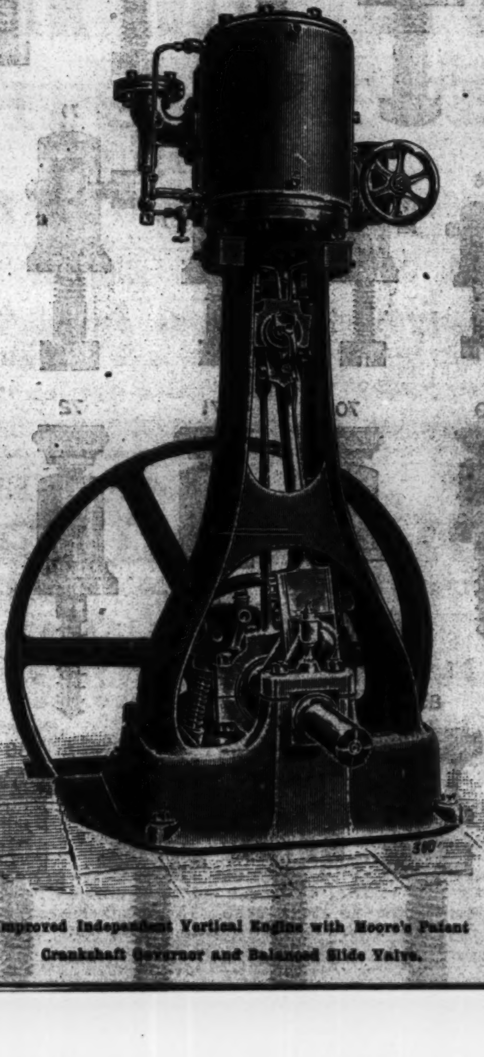

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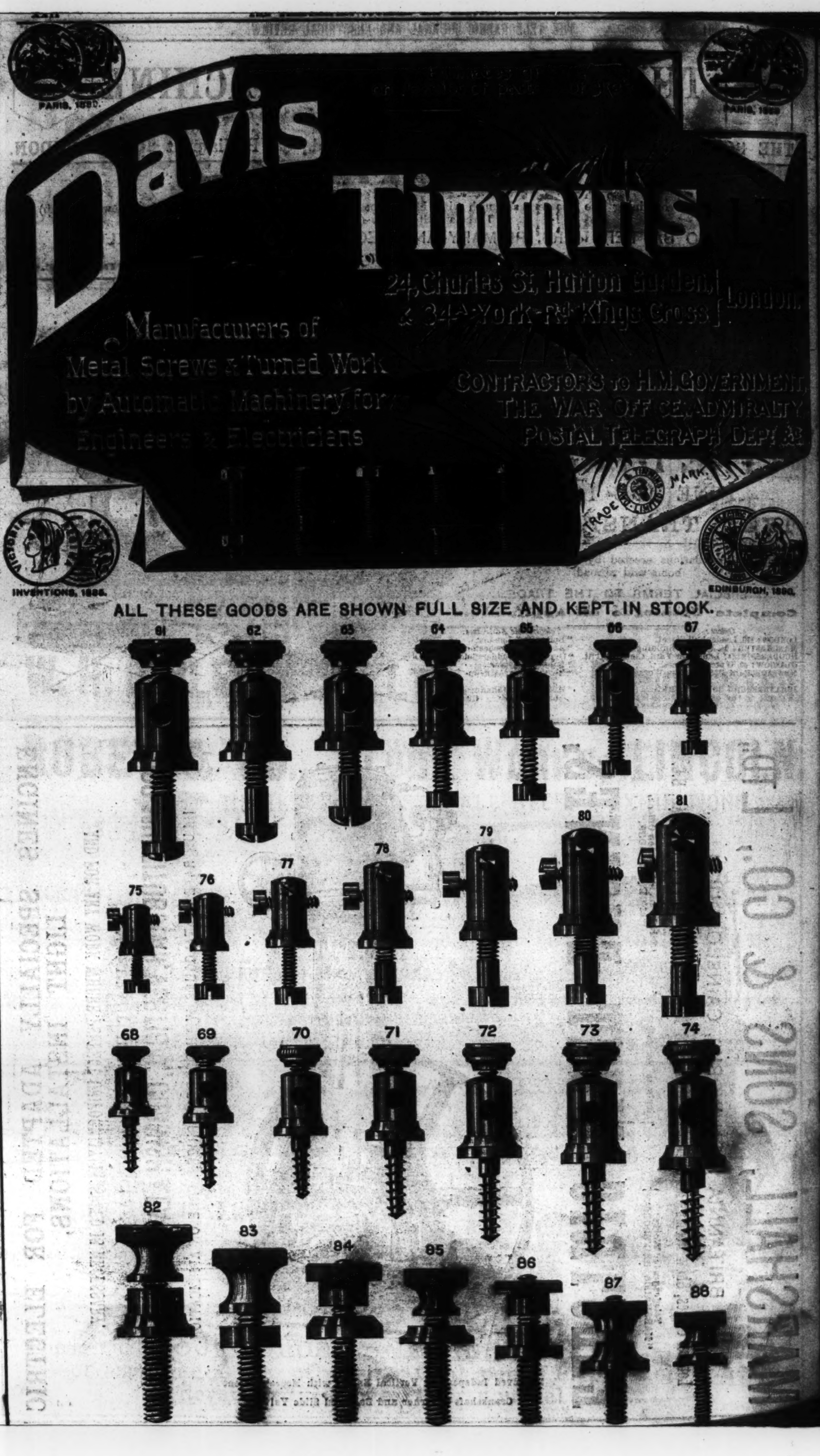

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